SLD 2 0236/P-5907

ISOPHTHALIC ACID POLYAMIDE POLYMER FOR USE IN GOLF BALL COVERS OR MANTLES

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Field of the Invention

The present invention relates to compositions suitable for golf ball constructions and to golf balls which employ such compositions. Specifically, these compositions comprise isophthalic acid polyamide polymers.

Background of the Invention

Modern golf balls typically employ ionomeric resins as cover materials. Ionomeric resins, as a result of their toughness, durability, and wide range of hardness values, have become materials of choice for golf ball covers over traditional rubbers. Ionomeric resins generally comprise an alpha-olefin and an alpha, beta ethylenically unsaturated mono- or dicarboxylic acid neutralized with metal ions to the extent desired. Olefins which have been employed to prepare ionomeric resins include ethylene, propylene, butene-1 and the like. Unsaturated carboxylic acids which have been employed to prepare ionomeric resins include acrylic, methacrylic, ethacrylic, chloroacrylic, crotonic, maleic, fumaric, itaconic and the like. Ionomeric resins include copolymers of ethylene with acrylic acid such as those sold by Exxon Corporation under the trademark Iotek®, as well as copolymers of ethylene with methacrylic acid such as those sold by E.I. DuPont Nemours & Company under the trademark Surlyn®. In some instances, a softening comonomer such as an acrylate ester has been included such that the ionomeric copolymer is an ionomeric terpolymer. Although various compositions have been employed to provide golf balls of varying playability characteristics, a need continues for compositions and covers which can be employed to provide golf balls which exhibit good playability and durability.

Generally, polyamides are polymers that contain recurring amide groups as integral parts of the main polymer chains. Amides are closely

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related to carboxylic acids. In a simple amide, the OH group of the carboxylic acid is replaced by an NH_2 group. Polyamides are frequently referred to by their generic term "nylons." Nylons are used in the production of synthetic fibers and engineering resins. A variety of polyamides exist including aromatic polyamides, polyamide fibers, and plastic polyamides.

As far as is known, there are no commercially available golf balls which contain nylon. Nylon alone would be too brittle for use in a golf ball cover. When efforts have been made in other fields to blend nylon with softer materials some degree of incompatibility often has resulted, rendering the blends susceptible to cracking and premature failure. U.S. Patent No. 4,690,981, the contents of which are incorporated herein by reference, shows soft terpolymer ionomers of ethylene/unsaturated carboxylic acid/softening comonomer which are useful in injection-molded items such as ski boots, ice skate shells, as coatings for fabrics, and as a replacement for balata in golf balls. The unsaturated carboxylic acid may be, for example, acrylic acid and/or methacrylic acid. The softening comonomer is, for example, an alkyl acrylate such as n-butyl acrylate. The '981 patent briefly mentions that the ionomers can be blended with other materials such as nylon, polypropylene, propylene-ethylene copolymers, linear polyethylene, and ethylene/unsaturated carboxylic acid copolymers. However, there is no indication that blends can be used for golf balls.

In view of known strength and durability properties of nylon, it would be desirable to somehow utilize nylon in the construction of a golf ball. Specifically, it would be desirable to identify particular types of nylon materials that might be uniquely adapted to serve as materials for golf ball construction. There is a particular need for improved golf ball cover materials.

Summary of the Invention

The present invention achieves the above-noted objectives and provides, in a first aspect, a golf ball having a cover and a centrally

disposed core in which the cover includes a combination of an ionomer and an isophthalic acid polyamide. The isophthalic acid polyamide is formed from reacting at least one of phthalic acid, isophthalic acid, and terephthalic acid.

In another aspect, the present invention provides a golf ball comprising a core and a cover layer disposed about the core. The cover layer includes an isophthalic acid polyamide.

In yet another aspect, the present invention provides a golf ball comprising a core, a mantle layer disposed about the core, and a cover layer disposed on the mantle. The mantle layer and/or the cover layer comprises an isophthalic acid polyamide.

In a further aspect, the present invention provides a method of making a golf ball comprising the steps of obtaining a golf ball core and forming a cover layer about the core. The cover layer includes a resin composition that comprises a combination of an isophthalic acid polyamide component and an ionomeric component. The amount of the isophthalic acid polyamide is at least 10 weight percent of the resin composition.

The invention comprises the several steps and the relation of one or more such steps with respect to each of the others, and the article possessing the features, properties and the relation of elements exemplified in the following detailed disclosure.

Brief Description of the Drawings

Fig. 1 shows a cross-sectional view of a golf ball with a cover comprising an isophthalic acid polyamide material or resin.

Fig. 2 shows a multi-layered ball with a cover comprising an isophthalic acid polyamide.

Fig. 3 schematically shows a durability test apparatus used to determine the durability of the golf balls of the invention.

Fig. 4 is a partial side view of a portion of an insert plate in the durability test apparatus which has grooves intended to simulate a golf club face.

Detailed Description of the Preferred Embodiments

The present invention relates to golf balls which employ polyamide containing compositions, preferably as inner and/or outer cover compositions of golf balls having a core and one, two, or more cover layers formed thereon. Some non-limiting examples of compositions according to the invention are as follows:

(1) the reaction product ("RP") of a 3-part reactive mixture of polyamide, ionomeric copolymer, and ester,

(2) RP and at least one non-ionomeric terpolymer,

(3) RP with at least one ionomeric copolymer,

(4) a polyamide homopolymer and/or copolymer combined with at least one ionomeric copolymer, and

(5) a polyamide homopolymer and/or copolymer combined with at least one non-ionomeric carboxylic acid-containing terpolymer.

Specifically, in accordance with the present invention, a hard, heat-resistant impact modified polyamide is used in a golf ball cover or mantle. The polyamide material is preferably an isophthalic acid polyamide. The polyamide can be modified with an ethylene-acrylic acid or ethylene-methacrylic acid copolymer that is either used in such a form or ionomerized. Also, the polyamide may be modified with other modifiers including modified (maleated) polyolefins.

The low spin golf balls of the invention preferably have a coefficient of restitution of at least 0.780 and more preferably at least 0.800. The Shore D hardness of a hard nylon-containing cover layer generally is at least 65 (measured generally in accordance with ASTM D-2240, but measured on the curved surface of the ball). The PGA compression of the hard cover layer generally is 85 - 117, more preferably 90 - 105, and most preferably 90 - 97. The high spin, softer golf balls of the invention preferably have a C.O.R. of at least 0.775 and more preferably at least 0.790, a Shore D hardness of 30 - 60, and a PGA compression of 70 - 100, more preferably 75 - 95 and most preferably 75 - 85. Both hard and soft nylon-containing covers preferably have a melt index of 0.5 - 20 g/10 min.,

more preferably 0.5 - 8 g/10 min., and most preferably 1 - 4 g/10 mins.

An "ionomeric copolymer" as this term is used herein is a copolymer of an alpha-olefin and an alpha, beta-ethylenically unsaturated mono- or dicarboxylic acid with at least 3% of the carboxylic acid groups being neutralized with metal ions. The alpha-olefin preferably has 2 - 8 carbon atoms, the carboxylic acid preferably is acrylic acid, methacrylic acid, maleic acid, or the like and the metal ions include at least one cation selected from the group consisting of ions of zinc, magnesium, lithium, barium, potassium, calcium, manganese, nickel, chromium, tin, aluminum, sodium, copper, or the like. Preferably the cation is zinc, sodium or lithium or a combination thereof. The term "copolymer" includes (1) copolymers having two types of monomers which are polymerized together, (2) terpolymers (which are formed by the polymerization of three types of monomers), and (3) copolymers which are formed by the polymerization of more than three types of monomers.

A "polyamide component" as used herein is a polyamide homopolymer, a polyamide copolymer containing two or more types of amide units, e.g. nylon 6, 12, or a combination of both a polyamide homopolymer and a polyamide copolymer. The polyamide component preferably is a long chain polymer, not an oligomer, which typically is a short chain polymer of 2 - 10 units. An "ionomeric component" is (a) a non-polyamide-containing ionomeric copolymer which is capable of being mixed or blended with the polyamide component, (b) the ionomeric portion of a polyamide-containing ionomeric copolymer, or a combination of both (a) and (b). If the polyamide component and ionomeric component are bonded to one another, the acid portion of the ionomeric component preferably is neutralized before the reaction of the polyamide and ionomeric components, but most probably could also be neutralized after the reaction of the polyamide and ionomeric components.

The nomenclature for polyamides is as follows. When polyamides are identified by a single number, that polyamide product is formed from a single reactant and the number represents the number of carbon atoms in

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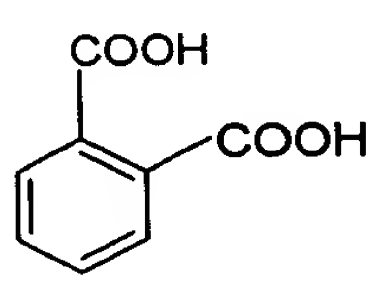
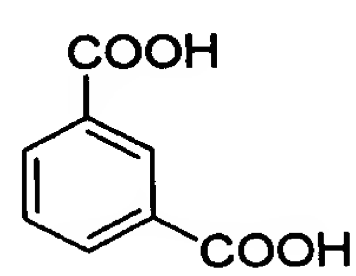
the linear chain of the recurring polymer unit. When two reactants are used in the manufacture, they are represented by two numbers separated by a comma. The first number refers to the number of carbon atoms in the diamine and the second number to the number of carbon atoms in the dibasic acid. Thus, for example, the polyamide from caprolactam is known as nylon-6 and that from hexamethylenediamine and adipic acid as nylon -6,6. Polyamide copolymers are denoted by a slash "/". For example, nylon -6/6,6 is a copolymer of a polyamide from caprolactam (nylon -6) and a polyamide from hexamethylenediamine and adiopic acid (nylon -6,6).

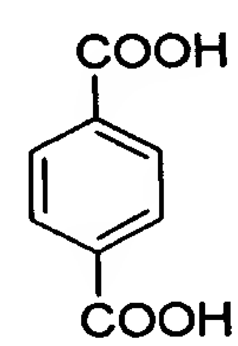
Isophthalic acid and related isomers phthalic acid and terephthalic acid are aromatic carboxylic acids. Isophthalic acid reacts with other chemicals to form polyamides, esters, salts, acid chlorides and other derivatives. Worldwide, the primary producers of isophthalic acid are the BP Amoco Corporation in the United States and Belgium, Societ Italiana Serie Acetica Sintetica SpA (SISAS) in Italy, and A.G. International Chemical Co., Inc., in Japan. Below are the structural formulas of isophthalic acid, phthalic acid, and terephthalic acid.



Phthalic Acid



Isophthalic Acid



Terephthalic Acid

Selected physical and chemical properties of isophthalic acid are shown in Tables 1 and 2.

TABLE 1

Physical Constants and Properties of Isophthalic Acid

Property	Value
Melting Point (closed tube), °C	345-348
Vapor Pressure, kPa[a]	
at 100°C	0.009
125°C	0.08
230°C	0.23
260°C	1.03
290°C	3.98
Specific Gravity at 4°C	1.53
Heat of Combustion at 25°C, kJ/mol[b]	-3202
Heat of Formation at 25°C, kJ/mol[b]	-802
Heat of Sublimation at 25°C, kJ/mol[b]	106.7

[a]To convert kPa to mm Hg, multiply by 7.5.
[b]To convert J to cal, divide by 4.184.

TABLE 2
Solubilities of Isophthalic Acid[a]

	Temperature, °C				
Solvent	**25**	**50**	**100**	**150**	**200**
water	0.012	0.035	0.32	2.8	25
acetic acid (glacial)	0.23	0.41	1.3	4.3	11.1
methanol	2.5	4.0			
1-propanol	1.7	2.7	7.0		
dimethylformamide	37				
dimethyl sulfoxide	64				

[a]g/100 g solvent

An "isophthalic acid polyamide" as used herein is a polyamide that is formed from reacting one or more of phthalic acid, isophthalic acid, and terephthalic acid.

A particular form of isophthalic acid polyamide resins known as polyphthalamides has excellent mechanical properties such as strength, stiffness and fatigue resistance over a broad temperature range. For instance, a 45 percent glass-reinforced grade exhibits a flexural strength of 45,000 psi (310 MPa) and a modulus of over 2 million psi (13.8 GPa) and is virtually unaffected by typical moisture or humidity levels. Other properties are set forth below in Table 3.

TABLE 3

Properties of Polyphthalamide, Dry as Molded

Property	Polyphthalamide (PPA)
water absorption, %	
24 h	0.81
50% rh	
saturation	
melting point, °C	310
glass-transition temperature, T_g, °C	123-135
tensile strength, MPa[a]	104
flexural modulus, MPa[a]	3300
elongation at break, %	6.4
notched Izod impact strength, J/m[b]	53
DTUL[c] at 1.8 MPa[a], °C	120
starting materials	
amine	hexamethylene-diamine
acid	adipic acid, iso/terephthalic acids

[a]To convert MPa to psi, multiply by 145.
[b]To convert J/m to ft·lbf/in., divide by 53.38.
[c]Deflection temperature under load.

Polyphthalamide resins are readily fabricated with competitive cycle times into many intricate parts using conventional molding equipment. Molded parts exhibit very low warpage and shrinkage, and the resin does not corrode tooling or require critical drying procedures, as do polyesters and polycarbonates.

A particularly preferred form of polyphthalamide resin is Amodel®, which is produced by the BP Amoco Corporation. Amodel® is formed from isophthalic, phthalic or terephthalic acid, or a combination thereof. Amodel® is a semi-crystalline engineering polymer which, according to BP, bridges the cost-performance gap between traditional engineering thermoplastics such as polycarbonates, nylons, polyesters and acetals and higher cost specialty polymers such as liquid crystal polymers, polyphenylene sulfide and polyether imide. Properties of a most preferred Amodel® resin are set forth below in Table 11.

A range of Amodel® resin grades are available. Unreinforced grades are formulated for injection molding and extrusion applications which require high surface gloss, lubricity, low warpage and toughness, along with

a high level of mechanical performance at elevated temperatures.

Glass-filled grades provide higher stiffness, strength and elevated temperature creep-resistance for structural type applications. Mineral-filled resins offer enhanced dimensional stability and flatness. Some of the Amodel® grades can be plated, epoxy coated and oven cured.

Combination mineral glass products may be added to the polyphthalamide polymer to provide a balance between dimensional-type properties and increased stiffness and strength that glass-reinforced grades provide.

Impact-modified grades may be added to the polyphthalamide polymer to provide significantly improved toughness comparable to the super-tough nylons, but with much higher strength and stiffness across a broad humidity and temperature range.

In the present development, the isophthalic acid polyamide composition formed is utilized as a component of a golf ball cover or mantle, or alternatively, may be blended with other comparable components, such as acrylic and methacrylic ionomers.

The high degree of hardness of the isophthalic acid polyamide resin decreases the spin rates of a golf ball when hit by a golf club, and increases the distance which a ball travels. Also, the high degree of hardness provides excellent durability, such as measured by the barrel test.

The details of interaction between a polyamide and an ionomeric copolymer are not fully understood. A polyamide and an ionomer could, for example, be intimately mixed without any bonding but with specific intermolecular interactions. Furthermore, it is possible, in combining a specific quantity of polyamide with a specific quantity of ionomeric copolymer, that portions of the overall quantities of the polyamide component and ionomeric component could be bonded to each other, as in a graft reaction, while other portions of the polyamide component and ionomeric component could form a blend which may have specific intermolecular interactions. Thus, this application is not intended to be limited by the degree of bonding versus intermolecular interaction of the

polyamide component and ionomeric component unless specifically indicated.

In a first embodiment, golf balls of the invention employ, preferably as a cover, a composition that is the reaction product ("RP") of a reactive mixture of polyamide, ionomeric copolymer, and an ester. The RP preferably is formed from a reactive mixture of at least one of isophthalic acid, phthalic acid, and terephthalic acid; zinc neutralized ethylene/methacrylic acid ionomer copolymer; and ethylene (meth)acrylate. As used herein, the term "(meth)acrylate" includes both acrylates and methacrylates. The polyamide preferably is about 50 wt. % to about 90 wt. % of the reactive mixture, the ionic copolymer is about 5 - 50 wt. % of the reactive mixture, and the copolymer is about 1 - 20 wt. % of the reactive mixture. More preferably, the polyamide is about 60 - 72 wt. % of the reactive mixture, the ionic copolymer is about 26 - 34 wt. % of the reactive mixture, and the ester copolymer, preferably olefin ester copolymer, is about 2 - 6 wt. % of the reactive mixture.

Commercially available products which are the reaction products of reactive mixtures of polyamide, ionic copolymer, and olefin ester copolymer include Capron® 8351, available from Allied Signal. This reactive mixture, and the processing thereof, is believed to be described in U.S. Patent No. 4,404,325, the teachings of which are incorporated herein by reference in their entirety. As described therein, the preferred polyamide is polyepsiloncaprolactam or polyhexamethyleneadipamide, most preferably polyespiloncaprolactam. The preferred olefin ester copolymer is ethylene/ethyl acrylate. The preferred ionic copolymer is a zinc neutralized copolymer of ethylene/methacrylic acid available from DuPont under the trade name Surlyn® 9721 (1801). According to claim 7 of U.S. Patent No. 4,404,325, the polyamide is present in the reactive mixture in an amount of about 60 - 72 wt. %, the ionomeric copolymer is present in an amount of about 26 wt. % to about 34 wt. %, and the olefin ester copolymer is present in an amount of about 2 to about 6 wt. %, based on the total weight of the reactive mixture. It is believed that Capron® 8351 has a nylon backbone

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with ionomer grafted thereto. Allied Signal states that Capron® 8351 is a graft copolymer which has the properties shown in Table 4 below.

Table 4

Property	Test Method (ASTM)	Value
Specific Gravity	D-792	1.07
Yield Tensile Strength, psi (MPa)	D-638	7800 (54)
Ultimate Elongation %	D-638	200
Flexural Strength, psi (MPa)	D-790	9500 (65)
Flexural Modulus, psi (MPa)	D-790	230,000 (1585)
Notched Izod Impact ft-lbs/in	D-256	No break
Drop weight Impact ft-lbs (J)	D-3029	150 (200)
Drop weight Impact @ -40F, ft-lbs (J)	D-3029	150 (200)
Heat Deflection temp. @ 264 psi, °C	D-648	60
Melting Point, °C	D-789	215

Capron® 8351 is the most preferred RP for use in the invention. Variations of Capron® 8351 also may be used. For example, variations of Capron® 8351 which may be used include those which employ polyepsiloncaprolactam or polyhexamethyleneadipamide with olefin ester copolymers such as ethylene/methyl acrylate, ethylene/ethyl methacrylate, and ethylene/methyl methacrylate. Ionic copolymers which may be used in variations of Capron® 8351 include ionic copolymers of an alpha olefin of the formula $RCH=CH_2$ where R is H or alkyl radicals having 1-8 carbons, and an alpha, beta ethylenically unsaturated carboxylic acid having from 3-8 carbons. The ionic copolymer has at least about 10 wt. % of the COOH groups neutralized with metal cations, preferably zinc. Examples of these ionic copolymers include zinc neutralized ethylene/methacrylic acid. In variations of Capron® 8351, the reactive mixture neutralized to produce

such variations may include about 50 wt. % to about 90 wt. % polyamide, about 5 wt. % to 50 wt. % ionic copolymer, and about 1 wt. % to 20 wt. % olefin ester copolymer, all percents based on the weight of the reactive mixture.

In another embodiment, golf balls of the invention employ, preferably as a cover, a composition that includes RP and at least one terpolymer. Terpolymers which may be employed include olefin/alkyl (meth)acrylate/carboxylic acid terpolymers. These terpolymers typically have about 50 - 98 wt. % olefin, about 1 - 30 wt. % alkyl acrylate, and about 1 - 20 wt. % carboxylic acid. The olefin may be any of ethylene, propylene, butene-1, hexene-1 and the like, preferably ethylene. The alkyl (meth)acrylate may be any of methyl acrylate, methyl methacrylate, ethyl acrylate, ethyl methacrylate, butyl acrylate, butyl methacrylate, butyl vinyl ether, methyl vinyl ether, and the like, preferably methyl acrylate. The carboxylic acid may be any one of acrylic acid, methacrylic acid, maleic acid, and fumaric acid. Monoesters of diacids such as methyl hydrogen maleate, methyl hydrogen fumarate, ethyl hydrogen fumarate, and maleic anhydride which is considered to be a carboxylic acid may also be used. Preferably, the carboxylic acid is acrylic acid. Useful ethylene/methyl acrylate/acrylic acid terpolymers may comprise about 50 - 98 wt. %, preferably about 65 - 85 wt. %, most preferably about 76 wt. % ethylene, about 1 - 30 wt. % preferably 15 - 20 wt. %, most preferably about 18 wt. % methyl acrylate, and about 1 - 20 wt. %, preferably about 4 - 10 wt. %, most preferably about 6 wt. % acrylic acid.

Olefin/alkyl (meth)acrylate/carboxylic acid terpolymers which are preferred for use in the compositions employed in the invention are ethylene/methyl acrylate/acrylic acid terpolymers such as those marketed by Exxon Chemical Co. under the name Escor®. Examples of these terpolymers include Escor® ATX 320 and Escor® ATX 325. The properties of Escor® ATX 320 and Escor® ATX 325 as provided by Exxon are presented in Table 5.

Table 5

Property/Resin	Escor® ATX-320	Escor® ATX-325
Melt Index[1]	5.0g/10 min	20.0g/10 min
Density[1]	0.950 g/cc	0.950 g/cc
Melting Point[1]	69°C	67°C
Crystallization Temperature[1]	51°C	50°C
Vicat Softening Temperature 200g[2]	66°C	60°C
Tensile Strength @ yield[3]	12 MPa	7.8 MPa
Hardness[4]	34	30
Elongation @ break[3]	>800%	>800%

[1] Exxon Method
[2] ASTM D 1525
[3] ASTM 638
[4] Shore D

Other olefin/alkyl (meth)acrylate/carboxylic acid terpolymers which may be employed with RP in the compositions employed in the invention include but are not limited to:

ethylene/n-butyl acrylate/acrylic acid,
ethylene/n-butyl acrylate/methacrylic acid,
ethylene/2-ethoxyethyl acrylate/acrylic acid,
ethylene/2-ethoxyethyl acrylate/methacrylic acid,
ethylene/n-pentyl acrylate/acrylic acid,
ethylene/n-pentyl acrylate/methacrylic acid,
ethylene/n-octyl acrylate/acrylic acid,
ethylene/2-ethyhexyl acrylate/acrylic acid,
ethylene/n-propyl acrylate/acrylic acid,
ethylene/n-propyl acrylate/methacrylic acid,
ethylene/n-heptyl acrylate/acrylic acid,
ethylene/2-methoxylethyl acrylate/acrylic acid,
ethylene/3-methoxypropyl acrylate/acrylic acid,
ethylene/3-ethoxypropyl acrylate/acrylic acid, and
ethylene/acrylate/acrylic acid.

Compositions which may be employed to provide golf balls according

to this embodiment of the invention include about 1 to about 90 wt. %, preferably about 1 to about 30 wt. %, most preferably about 15 wt. % RP and about 99 wt. % to about 10 wt. % terpolymer, preferably about 99 wt. % to about 70 wt. %, most preferably about 85 wt. % terpolymer.

In another embodiment, golf balls of the invention employ, preferably as a cover, compositions which include RP and an olefin/alkyl acrylate/carboxylic acid terpolymer ionomer. Typically, the carboxylic acid groups of the terpolymer ionomer are partially (i.e., approximately 5 - 80 percent) neutralized by metal ions such as lithium, sodium, zinc, manganese, nickel, barium, tin, calcium, magnesium, copper, and the like, preferably zinc, sodium or lithium or a combination thereof, most preferably zinc or lithium or a combination thereof. These terpolymer ionomers usually have a relatively high molecular weight, e.g., a melt index of about 0.1 to 1000 g/10 min., and/or a weight average molecular weight of 5000 up to one million. The ethylene/methyl acrylate/acrylic acid terpolymer ionomer may comprise about 50 - 98 wt. %, preferably about 65 - 85 wt. %, most preferably about 76 wt. % ethylene, about 1 - 30 wt. %, preferably about 15 - 20 wt. %, most preferably about 18 wt. % methyl acrylate, and about 1 - 20 wt. %, preferably about 4 - 10 wt. %, most preferably about 6 wt. % acrylic acid. Useful terpolymer ionomers include, for example, ethylene/methyl acrylate/acrylic acid terpolymer ionomers sold by Exxon Chemical Co. under the designation Iotek®. Preferred terpolymer ionomers for use in the invention include zinc neutralized ethylene/methyl acrylate/acrylic acid terpolymer ionomers such as Iotek® 7520 and Iotek® 7510, and Li neutralized ionomers such as Escor® ATX-320-Li-80.

Escor® ATX 320 Li-80 is produced by utilizing a 6.0 wt. % acrylic acid/18.0 wt. % methyl acrylate/76 wt. % ethylene terpolymer produced by Exxon Chemical Co. under the designation Escor® ATX 320. The acid groups present in the terpolymer then are neutralized to 80 mol % by lithium using lithium hydroxymonohydrate. Neutralization is performed by adding lithium hydroxymonohydrate and Escor® ATX 320 terpolymer to an intensive mixer (Banbury® type). The lithium salt solubilizes in the ATX

320 terpolymer above the melting temperature of the terpolymer, and a vigorous reaction occurs with foaming as the lithium cation reacts with the acid groups of the terpolymer, and volatile byproducts are evaporated. The reaction is continued until foaming ceases (i.e., about 30 - 45 minutes at 250°F - 350°F) and the batch is removed from the Banbury® mixer. Mixing continues on a hot two-roll mill (175°F - 250°F) to complete the neutralization reaction.

For the purpose of determining the weight percent of neutralization of the acrylic acid groups in the terpolymer ionomer after reacting with the lithium salt, it is assumed that one mol of lithium neutralizes one mol of acrylic acid. The calculations of neutralization are based upon an acrylic acid molecular weight of 72 g/mol, giving 0.067 mols of lithium per 100 grams of the terpolymer.

Although Escor® ATX 320 terpolymer can be 80 mol % neutralized by lithium, it is to be understood that other degrees of neutralization with lithium, ranging from about 3 mol % to about 90 mol % may be employed to provide useful ionomers. Thus, for example, ATX 320 that is 20 mol % neutralized by lithium, hereinafter referred to as ATX 320-Li-20 may be employed. In addition, various cation salts such as salts of sodium, potassium, magnesium, manganese, calcium and nickel may be employed in a manner similar to lithium salts to provide various other Escor® ATX 320 type terpolymer ionomers.

Other terpolymer ionomers which may be used in the compositions employed in this embodiment of the invention include ethylene/alkyl ester/methacrylic acid terpolymer ionomers such as those disclosed in U.S. Patent No. 4,690,981, the teachings of which are incorporated by reference in its entirety herein, and which are available from DuPont Corp. under the trade name Surlyn®. Properties of five Surlyn® terpolymer ionomers which may be used in the invention are set forth in Table 6. The terpolymer ionomer may be about 1 wt. % to about 99 wt. %, preferably about 50 wt. % to about 99 wt. %, most preferably about 85 wt. %, all amounts based on the total weight of the RP-terpolymer ionomer

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composition. RP may be about 1 wt. % to about 99 wt. %, preferably about 1 wt. % to about 50 wt. %, most preferably about 15 wt. %, all amounts based on the total weight of the composition.

Table 6

Resin/ Property	ASTM	Surlyn® 7930	Surlyn® 7940	Surlyn® 8020[1]	Surlyn® 8528	Surlyn® 8550	Surlyn® 8660	Surlyn® 8120[1]	Surlyn® 8320[1]	Surlyn® 9020[1]	Surlyn® 9320[1]	Surlyn® 9520	Surlyn® 9650	Surlyn® 9720	Surlyn® 9730	Surlyn® 9910	Surlyn® 9950	Surlyn® 9970
Cation		Li	Li	Na	Na	Na	Na	Na	Na	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn	Zn
Melt Flow Index (g/10min)	D-1238	1.8	[illegible].6	1	1.3	3.9	10	0.9	0.9	1.[illegible]	0.6	1.1	5	1	1.6	0.7	5.5	1.4
Density	D-792	0.94	0.94	0.95	0.94	0.94	0.94	0.94	0.94	0.96	0.94	0.95	0.96	0.96	0.95	0.97	0.96	0.95
Notched Izod	D-256	NB[1]	NB[1]	NB[1]	11.4	---	16	---	---	NB[2]		10.1	14.5	NB[1]	NB[1]	6.8	NB[1]	NB[1]
Tensile Impact (23C)ft-lb/in²	D-1822S	140	220	630	550	795	345	235	213	610		570	460	600	590	14[illegible]	485	360
Flexural Mod (23C)kpsi	D-790	67	61	[illegible]7	32	31.7	34	49.1	19.3	14	3.7	38	32	36	30	48	37	28
Yield Strength (kpsi)	D-638	2.8	2.2	---	1.8	1.6	[illegible].6	2.2	2.[illegible]	---	3.5	1.8	1.7	1.7	1.6	2	1.8	1.8
Elongation (%)	D-638	290	285	530	450	419	470	680	770	510	500	410	410	440	460	290	490	440
Hardness, Shore D	D-2240	63	68	56	60	60	62	38	25	55	40	60	63	61	63	64	62	62
Vicat Temp. (C)	D-1525-70 Rate B	62	63	61	73	78	71	51	48	57	454	74	71	71	73	62	66	61

[1] Terpolymer ionomers

[2] No Break

In another embodiment, golf balls of the invention employ, preferably as a cover, compositions of olefin/carboxylic acid copolymer ionomers made from two types of monomers and RP. Olefin/carboxylic acid copolymer ionomers which may be employed with RP include those wherein the carboxylic acid groups of the copolymer ionomer are partially (i.e., approximately 5 - 80 percent) neutralized by metal ions such as but not limited to lithium, sodium, zinc, and magnesium, preferably zinc and sodium. Ionic copolymers may be zinc neutralized ethylene/methacrylic acid ionomer copolymer, sodium neutralized ethylene/acrylic acid copolymer ionomers, and mixtures thereof. The zinc neutralized ethylene/acrylic acid copolymer ionomer can be the reaction product of zinc neutralization of an ethylene/acrylic acid copolymer having about 15 - 20 wt. % acrylic acid and a melt index of about 37 to about 100. These copolymer ionomers usually have a relatively high molecular weight, e.g., a melt index of about 0.1 to 1000 g/10 min., and/or a weight average molecular weight of 5000 up to one million. Useful copolymer ionomers include, for example, ethylene/acrylic acid copolymer ionomers sold by Exxon Chemical Co. under the designation Iotek® such as Iotek® 7030, Iotek® 7020, Iotek® 7010, Iotek® 8030, Iotek® 8020, and Iotek® 8000. Non-limiting examples of preferred Iotek® copolymer ionomers for use in the invention include Iotek® 7010, Iotek® 7030 and Iotek® 8000. Properties of various Iotek® copolymer ionomers are shown in Tables 7-8.

Table 7

Resin/Property	ASTM Method	Iotek® 4000	Iotek® 4010	Iotek® 7010	Iotek® 7020	Iotek® 7030	Iotek® 8000	Iotek® 8020	Iotek® 8030	Iotek® 7520	Iotek® 7510	Iotek® 3110
Cation		Zn	Zn	Zn	Zn	Zn	Na	Na	Na	Zn	Zn	Na
Melt Flow Index g/10 min	D-1238	2.5	1.5	0.8	1.5	2.5	0.8	1.6	2.8	2	0.8	1.3
Density kg/m^3	D-792	964	966	968	966	964	957	0.956	956	962	970	939
Melting Point, C	D-2240	85	84	83.5	84	85	83	84	87	67	67	95
Crystallization Point, C	D-638	58	56	55	56	58	45	47	49	39	38	58
Vicat Softening Point, C	D-638	60	60	60	60	60	54	54.5	55.5	40	40	75
Flexural Mod, MPa	D-790	155	175	190	175	155	320	340	355	30	35	260
Tensile Impact at 23C, KJ/m^2 (Type S Dumbbell, 2mm Thick Compression Plaques)	D-1822	480	520	550	520	480	570	550	500	780	950	580
Plaque Properties (2mm thick compression molding)												
Tensile Strength at Break MPa	D-638	22.6	23.5	24.5	23.5	22.6	33	32.5	32	12	15	28
Yield Point MPa	D-638	12	13	14	13	12	19	18.5	18	4	4	14
Elongation at Break %	D-638	460	450	440	450	460	370	380	410	680	570	510
1% Secant Modulus MPa	D-638	125	135	150	135	125	280	280	280	22	27	210
Shore D Hardness	D-2240	52	53	54	53	52	60	60	60	30	35	55

* Terpolymer ionomer

Table 8

Resin/Property	ASTM Method	EX 1001	EX 1004	EX 1006	EX 1007
Cation	EXXON	Na	Zn	Na	Zn
Melt Index (g/10 min)	D-1238	1.0	2.0	1.3	1.0
Melting Point (C)	D-3417	83.7	82.5	86	85.8
Crystallization Point (C)	D-3417	41.3	52.5	47.5	52.3
Plaque Properties (2mm thick compression molding)					
Tensile Strength at Break MPa	D-638	34.4	20.6	33.5	24.1
Yield Point MPa	D-638	21.3	14.0	19.3	13.8
Elongation at Break %	D-638	341	437	421	472
1% Secant Modulus MPa	D-638	356	128	314	154
1% Flexural Modulus MPa	D-790	365	130	290	152
Shore D Hardness	D-2240	63	53	58	51
Vicat Softening Point	D-1525	51.5	55	57	60.5

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Another embodiment of the invention is golf balls which employ, preferably as a cover, compositions of nylon homopolymer and/or copolymer and one or more olefin/alkyl acrylate/carboxylic acid terpolymer ionomers. Terpolymer ionomers which may be used with the nylon homopolymers preferably are ethylene/methyl acrylate/acrylic acid terpolymer ionomers. Nylon homopolymers for use in any of the compositions employed in the invention include but are not limited to nylon 6, nylon 6,6, and mixtures or copolymers thereof. Other nylons such as nylon 11, nylon 12, nylon 6,12, nylon 6,6 and nylon 46 also can be used as long as sufficient durability is achieved. In the case of nylon 6, a polyamide chain of about 140 - 222 repeating units is typically useful, but lower and higher molecular weight material may be employed. Capron® 8202, a nylon 6 type polymer available from Allied Signal, is preferred. According to Allied Signal, Capron® 8202 has the properties set forth in Table 9.

Table 9

Property	Test Method (ASTM)	Value
Specific Gravity	D-792	1.13
Yield Tensile Strength, psi (MPa)	D-638	11500 (80)
Ultimate Elongation %	D-638	70
Flexural Strength, psi (MPa)	D-790	15700 (110)
Flexural Modulus, psi (MPa)	D-790	410,000 (2825)
Notched Izod Impact, ft-lbs/in	D-256	1.0 (55)
Heat Deflection Temp., @ 264 psi, °C	D-648	65
Melting Point, °C	D-789	215
Rockwell Hardness, R Scale	D-785	119

Terpolymer ionomers which may be employed include but are not limited to those having 50 - 98 wt. %, preferably about 65 - 85 wt. %, most preferably about 76 wt. % ethylene, about 1 - 30 wt. %, preferably about 15 - 20 wt. %, most preferably about 18 wt. % methyl acrylate, about 1 - 20 wt. %, preferably about 4 - 10 wt. %, most preferably about 6 wt. % acrylic acid,

wherein the acrylic acid has been neutralized by zinc, lithium or sodium or combinations thereof. Preferred terpolymer ionomers include Iotek® 7520, Iotek® 7510, Escor® ATX 320-Li-80, or a mixture thereof. The nylon homopolymer may be present in the compositions an amount of about 1 wt. % to about 99 wt. %, preferably about 50 wt. % to 99 wt. %, most preferably about 15 wt. % of the composition. The terpolymer ionomer may be about 99 wt. % to about 1 wt. %, preferably about 99 wt. % to 50 wt. %, most preferably about 85 wt. %, all amounts based on total weight of the composition.

Zytel® 408 is a nylon 6,6 modified molding compound containing ionomer. It is believed that Zytel® 408 is an intimate mixture of polyamide and an ionomeric terpolymer of an alpha-olefin, an acrylate ester, and an alpha, alpha-ethylenically unsaturated mono- or dicarboxylic acid with a portion of the carboxylic acid groups being neutralized with metal ions. It is unknown to the present inventors whether Zytel® 408 is a graft copolymer or a blend; however, Zytel® 408 is believed to be a blend of nylon 66 and an ethylene alkylmethacrylate methacrylic acid terpolymer ionomer neutralized with zinc. The properties of Zytel® 408, as provided by DuPont, are shown in Table 10.

Table 10

Property	Test Method (ASTM)	Value[1]
Specific Gravity	D-792	1.09
Tensile Strength (-40°F)	D-638	15100 psi
Tensile Strength (-40°C)	D-638	104.1 MPa
Flexural Modulus (-40°F)	D-790	410,000 psi
Flexural Modulus (-40°C)	D-790	2827 MPa
Izod Impact Strength at -40°F	D-256	1.3 ft.lb./in.
Izod Impact Strength at -40°F	D-256	69 J/m
Gardner Impact at -30°F	D-3029	>320 ft.lbs.
Heat Deflection temp. @ 1.8×10^6 Pa	D-648	75°C
Melting Point	D-789	255°C

[1] Dry as molded, with about 0.2% water

A further embodiment of the invention is golf balls which employ, preferably as a cover, compositions of polyamide homopolymers or copolymers, and olefin/carboxylic acid copolymer ionomers made from two types of monomers such as Iotek®. The polyamides which can be used in the compositions employed in the invention include but are not limited to nylon 6, nylon 6,6, nylon 11, nylon 12, nylon 6,12, nylon 6,6/6, nylon 46 and mixtures thereof, as long as sufficient durability is achieved. Preferably, the nylon polymer is any of nylon 6 and nylon 6,6, and most preferably nylon 6. In the case of nylon 6, a polyamide chain of about 140-222 repeating units is typically useful, but lower and higher molecular weight material may be employed. A preferred polyamide homopolymer is Capron® 8202 available from Allied Signal. Useful copolymer ionomers include copolymer ionomers having about 99 wt. % to 70 wt. %, preferably about 90 wt. % to 80 wt. %, most preferably 85 wt. % ethylene, about 1 wt. % to about 30 wt. %, preferably about 10 wt. % to about 20 wt. %, most preferably 15 wt. % acrylic acid. A preferred ethylene/acrylic acid copolymer ionomer is Iotek® 7010 from Exxon Chemical Co. The copolymer ionomer may be present in the composition an amount of about 99 wt. % to about 1 wt. %, preferably about 95 wt. % to about 70 wt. %, most preferably about 80 wt. % of the composition. The polyamide homopolymer may be about 1 wt. % to about 99 wt. %, preferably about 5 wt. % to about 30 wt. %, most preferably about 20 wt. %, wherein all amounts are based on the total weight of the composition.

Two or more copolymer ionomers may be preblended prior to blending with polyamide homopolymers and/or RP to provide compositions which may be used in the invention. Thus, preblends of hard and soft copolymer ionomers, as well as preblends of high carboxylic acid copolymer ionomers and low carboxylic acid copolymer ionomers may be utilized to provide compositions for use in the invention. An example of such a preblend is a mixture of Iotek® 8000 and Iotek® 7010.

Another embodiment of the invention is golf balls which employ, preferably as a cover, compositions of polyamide homopolymers or

copolymers, and olefin/alkyl acrylate/carboxylic acid terpolymers. Useful terpolymers include terpolymers having about 50 - 98 wt. %, preferably about 65 - 85 wt. %, most preferably about 76 wt. % olefin, preferably ethylene, about 1 - 30 wt. %, preferably about 15 - 20 wt. %, most preferably about 18 wt. % alkyl acrylate, preferably methyl acrylate, and about 1 - 20 wt. %, preferably about 4 - 10 wt. %, most preferably about 6 wt. % carboxylic acid, preferably acrylic acid. The terpolymer may be present in the composition an amount of about 1 wt. % to about 99 wt. %, preferably about 50 wt. % to about 99 wt. %, most preferably about 85 wt. % of the composition. The polyamide homopolymer may be about 1 wt. % to about 99 wt. %, preferably about 1 wt. % to about 50 wt. %, most preferably about 15 wt. %, wherein all amounts are based on the total weight of the composition. Useful polyamides may be of polyepsiloncaprolactam and polyhexamethyleneadipamide, more preferably nylon 6, nylon 6,6, nylon 11, nylon 12, nylon 6,12, nylon 6,6/6, nylon 46 and mixtures thereof. Preferably, the nylon polymer is any of nylon 6 and nylon 6,6, still more preferably nylon 6, most preferably the nylon homopolymer sold by Allied Signal under the trade name Capron® 8202. A preferred ethylene/methyl acrylate/acrylic acid terpolymer is Escor® ATX 320 from Exxon Chemical Co.

Two or more terpolymers may be preblended prior to blending with any of RP or the polyamide homopolymers to provide compositions which may be used in the invention. Thus, preblends of hard and soft terpolymers, as well as preblends of high carboxylic acid terpolymers and low carboxylic acid terpolymers may be utilized to provide compositions for use in the invention.

A particularly preferred polyamide that can be used in the present invention is polyphthalamide. Polyphthalamides are a semi-crystalline, aromatic polyamide. Polyphthalamides may be formed from phthalic acid, isophthalic acid and terephthalic acid or a blend thereof. Phthalic acid, isophthalic acid and terephthalic acid are dicarboxylic acids attached to benzyl rings. Polyphthalamides are formed by including phthalic acid,

isophthalic acid or terephthalic acid into a long polyamide chain thereby creating a particular form of aromatic polyamide.

Polyphthalamide resins are preferred for use in golf ball components because of their outstanding physical properties. Polyphthalamide resins are particularly preferred for use in golf ball covers. Compared to nylon 6/6, polyphthalamides are stronger, stiffer, less sensitive to moisture and have higher thermal capabilities. Polyphthalamides have desirable mechanical properties and creep resistance. Polyphthalamides are characterized by having a high melting point (300-320°C), good dimensional stability, good chemical resistance, and low water absorption.

A most preferred commercially available polyphthalamide is available from the BP Amoco Company under the tradename Amodel®. Amodel® polyphthalamide resins offer high fatigue strength, stiffness, and creep resistance over a broad temperature and humidity range. Particularly preferred forms of Amodel® include Amodel® AT-1001 and Amodel® ET-1001 HS. Amodel® ET-1001 HS has the properties set forth in Table 11.

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Table 11

Property	Test Method ASTM	Typical Values			
		U.S. Customary Units		SI Units	
		DAM[1]	Units	DAM[1]	Units
Tensile Strength	D 638	11,000	psi	76	MPa
Tensile Elongation	D 638				
at Yield		6	%	6	%
at Break		30	%	30	%
Tensile Modulus	D 638	350	kpsi	2.4	GPa
Flexural Strength	D 790	18,500	psi	128	MPa
Flexural Modulus	D 790	380	kpsi	2.6	GPa
Izod Impact, Notched	D 256	18	ft-lb/in	960	J/m
Penetration Impact at 73°F (23°C)	D 3763				
Maximum Load		1,260	lbs	5,600	N
Energy to Max. Load		32	ft-lbs	43	J
Total Energy Absorbed		47	ft-lbs	64	J
Penetration Impact at -10°F (-23°C)	D 3763				
Maximum Load		1,460	lbs	6,500	N
Energy to Max. Load		34	ft-lbs	46	J
Total Energy Absorbed		49	ft-lbs	66	J
Poisson=s Ratio		0.35		0.35	
Deflection Temperature at 264 psi (1.8 MPa)	D 648	248	°F	120	°C
Melting Point	D 3418	590	°F	310	°C
Specific Gravity	D 792	1.15		1.15	
Moisture Absorption, 24 hours	D 570	0.65	%	0.65	%
Mold Shrinkage[2]					
Flow Direction		1.5-2.0	%	1.5-2.0	%
Transverse Direction		1.5-2.0	%	1.5-2.0	%

[1] DAM = dry, as molded
[2] Measured using a 4 x 4 x 1/8th inch (102 x 102 x 3 mm) plaque

Polyphthalamide materials or resins may be present in the golf ball component in an amount of 10 - 60 wt. %, preferably about 15 - 50 wt. %,

and most preferably about 20 - 40 wt. %, based upon the weight of the component, e.g., a cover for instance. More specifically, it is preferred that the present invention golf balls utilize cover compositions that comprise polyphthalamide or polyphthalamide materials in the noted proportions. Such cover compositions further comprise ionomeric or non-ionomeric materials in amounts of about 90 - 40 wt. %, preferably of about 85 - 50 wt. %, and most preferably about 80 - 60 wt. %. The coefficient of restitution of a golf ball having polyphthalamide in the above ranges is at least 0.750, and preferably at least 0.800. The Riehle compression of a golf ball having polyphthalamide in the above amounts is no more than 75, and preferably less than 71.

Referring now to the drawings, and first to Fig. 1, a golf ball 10 including a core 12 and a cover 14 comprising an isophthalic acid polyamide material or resin is shown.

Fig. 2 shows a multi-layered golf ball 20 having a core 22, an intermediate layer 24, and a cover 26 comprising an isophthalic acid polyamide.

Although the compositions employed in the invention may be used in golf ball construction including solid cores, one-piece balls and covers, these compositions are preferably employed as covers. Golf ball covers can be produced by injection molding or compression molding the nylon containing compositions employed herein over a wound or solid molded core, or a liquid core, to produce a golf ball having a diameter of about 1.680 inches and weighing about 1.620 ounces. In golf balls comprising multi-layered covers, any of the cover layers may comprise the nylon-containing compositions employed herein.

The core itself may be of a uniform composition, or may have two or more layers. The standards for both the diameter and weight for golf balls are established by the United States Golf Association (U.S.G.A.). Although the compositions employed in the invention can be used in solid core, two-piece and wound balls, solid and two-piece balls are preferred over wound balls due to their lower cost and superior performance. The term "solid

cores" as used herein refers not only to one piece cores but also to multi-layer cores.

Golf balls of the invention may be produced by forming covers which include compositions of the invention around cores by conventional molding processes. The cover material is mixed in a rigorous mixing procedure, preferably using a twin screw extruder or the like and an extrusion temperature of 200 - 250°C. The cover compositions may be injection molded directly around the core while the core is positioned in the center of a golf ball mold at temp of about 350°F to about 450°F. In compression molding, the cover composition is first injection molded at about 380°F to about 450°F to provide smooth surfaced hemispherical shells. The shells are then positioned around the core in a dimpled golf ball mold and compression molded at about 230-300°F for about 2 minutes to about 10 minutes at a pressure sufficient to retain the mold in a closed position. Thereafter, the mold is cooled at about 50°F to about 70°F for about 2 minutes to about 10 minutes to fuse the shells together to form a unitary ball. After molding, the resulting golf balls may undergo various further processing steps such as buffing, painting and marking.

The present invention is further illustrated by the following non-limiting examples set forth below. In many of the examples, the compositions are injection molded at 420 - 480°F (depending upon nylon content) around identical solid cores which have a finished diameter of 1.545" to produce golf balls about 1.680" in diameter having nominal cover thickness of 0.0675 inches. Each example represents the average data for one dozen balls produced according to the invention. The properties for the balls listed in the examples are measured according to the following procedures:

The resilience or coefficient of restitution (C.O.R.) of a golf ball is the constant "e," which is the ratio of the relative velocity of an elastic sphere after direct impact to that before impact. As a result, the C.O.R. ("e") can vary from 0 to 1, with 1 being equivalent to a perfectly or completely elastic

collision and 0 being equivalent to a perfectly or completely inelastic collision.

C.O.R., along with additional factors such as club head speed, club head mass, ball weight, ball size and density, spin rate, angle of trajectory and surface configuration (i.e., dimple pattern and area of dimple coverage) as well as environmental conditions (e.g. temperature, moisture, atmospheric pressure, wind, etc.) generally determine the distance a ball will travel when hit. Along this line, the distance a golf ball will travel under controlled environmental conditions is a function of the speed and mass of the club and size, density and resilience (C.O.R.) of the ball and other factors. The initial velocity of the club, the mass of the club and the angle of the ball's departure are essentially provided by the golfer upon striking. Since club head speed, club head mass, the angle of trajectory and environmental conditions are not determinants controllable by golf ball producers and the ball size and weight are set by the U.S.G.A., these are not factors of concern among golf ball manufacturers. The factors or determinants of interest with respect to improved distance are generally the coefficient of restitution (C.O.R.) and the surface configuration (dimple pattern, ratio of land area to dimple area, etc.) of the ball.

The C.O.R. in solid core balls is a function of the composition of the molded core and of the cover. The molded core and/or cover may be comprised of one or more layers such as in multi-layered balls. In balls containing a wound core (i.e., balls comprising a liquid or solid center, elastic windings, and a cover), the coefficient of restitution is a function of not only the composition of the center and cover, but also the composition and tension of the elastomeric windings. As in the solid core balls, the center and cover of a wound core ball may also consist of one or more layers.

The coefficient of restitution is the ratio of the outgoing velocity to the incoming velocity. In the examples of this application, the coefficient of restitution of a golf ball was measured by propelling a ball horizontally at a speed of 125 +/- 5 feet per second (fps) and corrected to 125 fps against

a generally vertical, hard, flat steel plate and measuring the ball's incoming and outgoing velocities electronically. Speeds were measured with a pair of Oehler Mark 55 ballistic screens available from Oehler Research, Inc., P.O. Box 9135, Austin, TX, which provide a timing pulse when an object passes through them. The screens were separated by 36" and are located 25.25" and 61.25" from the rebound wall. The ball speed was measured by timing the pulses from screen 1 to screen 2 on the way into the rebound wall (as the average speed of the ball over 36"), and then the exit speed was timed from screen 2 to screen 1 over the same distance. The rebound wall was tilted 2 degrees from a vertical plane to allow the ball to rebound slightly downward in order to miss the edge of the cannon that fired it. The rebound wall is preferably solid steel.

As indicated above, the incoming speed should be 125 +/- 5 fps but corrected to 125 fps. The correlation between C.O.R. and forward or incoming speed has been studied and a correction has been made over the +/- 5 fps range so that the C.O.R. is reported as if the ball had an incoming speed of exactly 125.0 fps.

The coefficient of restitution must be carefully controlled in all commercial golf balls if the ball is to be within the specifications regulated by the United States Golf Association (U.S.G.A.). As mentioned to some degree above, the U.S.G.A. standards indicate that a "regulation" ball cannot have an initial velocity exceeding 255 feet per second in an atmosphere of 75°F. when tested on a U.S.G.A. machine. Since the coefficient of restitution of a ball is related to the ball's initial velocity, it is highly desirable to produce a ball having sufficiently high coefficient of restitution to closely approach the U.S.G.A. limit on initial velocity, while having an ample degree of softness (i.e., hardness) to produce enhanced playability (i.e., spin, etc.).

Cold cracking resistance is measured by firing a ball, having been previously stored at 10°F for 24 hours, at a velocity of 165 ft/sec from an air cannon against a steel plate positioned 12 feet from the muzzle of the

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cannon. The ball is fired 5 times against the plate. After allowing the ball to equilibrate to room temperature, the ball is visually inspected to identify cracks in the cover. One or more cracks, no matter how small, constitute failure.

The term "compression" utilized in the golf ball trade generally defines the overall deflection that a golf ball undergoes when subjected to a compressive load. For example, PGA compression indicates the amount of change in golf ball's shape upon striking. The development of solid core technology in two-piece balls has allowed for much more precise control of compression in comparison to thread wound three-piece balls. This is because in the manufacture of solid core balls, the amount of deflection or deformation is precisely controlled by the chemical formula used in making the cores. This differs from wound three-piece balls wherein compression is controlled in part by the winding process of the elastic thread. Thus, two-piece and multilayer solid core balls exhibit much more consistent compression readings than balls having wound cores such as the thread wound three-piece balls.

In the past, PGA compression related to a scale of from 0 to 200 given to a golf ball. The lower the PGA compression value, the softer the feel of the ball upon striking. In practice, tournament quality balls have compression ratings around 70 - 110, preferably around 80 to 100.

In determining PGA compression using the 0 - 200 scale, a standard force is applied to the external surface of the ball. A ball which exhibits no deflection (0.0 inches in deflection) is rated 200 and a ball which deflects 2/10th of an inch (0.2 inches) is rated 0. Every change of .001 of an inch in deflection represents a 1 point drop in compression. Consequently, a ball which deflects 0.1 inches (100 x .001 inches) has a PGA compression value of 100 (i.e., 200 - 100) and a ball which deflects 0.110 inches (110 x .001 inches) has a PGA compression of 90 (i.e., 200 - 110).

In order to assist in the determination of compression, several devices have been employed by the industry. For example, PGA compression is determined by an apparatus fashioned in the form of a small

press with an upper and lower anvil. The upper anvil is at rest against a 200-pound die spring, and the lower anvil is movable through 0.300 inches by means of a crank mechanism. In its open position the gap between the anvils is 1.780 inches, allowing a clearance of 0.100 inches for insertion of the ball. As the lower anvil is raised by the crank, it compresses the ball against the upper anvil, such compression occurring during the last 0.200 inches of stroke of the lower anvil, the ball then loading the upper anvil which in turn loads the spring. The equilibrium point of the upper anvil is measured by a dial micrometer if the anvil is deflected by the ball more than 0.100 inches (less deflection is simply regarded as zero compression) and the reading on the micrometer dial is referred to as the compression of the ball. In practice, tournament quality balls generally have compression ratings around 80 to 100 which means that the upper anvil was deflected a total of 0.120 to 0.100 inches.

An example to determine PGA compression can be shown by utilizing a golf ball compression tester produced by Atti Engineering Corporation of Newark, N.J. The value obtained by this tester relates to an arbitrary value expressed by a number which may range from 0 to 100, although a value of 200 can be measured as indicated by two revolutions of the dial indicator on the apparatus. The value obtained defines the deflection that a golf ball undergoes when subjected to compressive loading. The Atti test apparatus consists of a lower movable platform and an upper movable spring-loaded anvil. The dial indicator is mounted such that it measures the upward movement of the springloaded anvil. The golf ball to be tested is placed in the lower platform, which is then raised a fixed distance. The upper portion of the golf ball comes in contact with and exerts a pressure on the springloaded anvil. Depending upon the distance of the golf ball to be compressed, the upper anvil is forced upward against the spring.

Alternative devices have also been employed to determine compression. For example, Applicant also utilizes a modified Riehle Compression Machine originally produced by Riehle Bros. Testing Machine

Company, Philadelphia, Pennsylvania to evaluate compression of the various components (i.e., cores, mantle cover balls, finished balls, etc.) of the golf balls. The Riehle compression device determines deformation in thousandths of an inch under a fixed initialized load of 200 pounds. Using such a device, a Riehle compression of 61 corresponds to a deflection under load of 0.061 inches.

Additionally, an approximate relationship between Riehle compression and PGA compression exists for balls of the same size. It has been determined by Applicant that Riehle compression corresponds to PGA compression by the general formula PGA compression = 160 - Riehle compression. Consequently, 80 Riehle compression corresponds to 80 PGA compression, 70 Riehle compression corresponds to 90 PGA compression, and 60 Riehle compression corresponds to 100 PGA compression. For reporting purposes, Applicant's compression values are usually measured as Riehle compression and converted to PGA compression.

Furthermore, additional compression devices may also be utilized to monitor golf ball compression so long as the correlation to PGA compression is know. These devices have been designed, such as a Whitney Tester, to correlate or correspond to PGA compression through a set relationship or formula.

Durability is determined by firing a golf ball at 135 ft/sec (at 72°F) into 5-sided steel pentagonal container, the walls of which are steel plates. The container 10, which is shown schematically in Fig. 3, has a 19½ inch long insert plate 12 mounted therein, the central portion 14 of which has horizontally extending square grooves on it which are intended to simulate a square grooved face of a golf club. The grooves, which are shown in an exaggerated form in Fig. 4, have a width 30 of 0.033 inches, a depth 32 of 0.100 inches, and are spaced apart from one another by land areas 34 having a width of 0.130 inches. The five walls 16 of the pentagonal container each have a length of 14½ inches. The inlet wall is vertical and

the insert plate is mounted such that it inclines upward 60° relative to a horizontal plane away from opening 20 in container 10. The ball travels 15½ - 15 3/4 inches horizontally from its point of entry into the container 10 until it hits the square-grooved central portion 14 of insert plate 12. The angle between the line of trajectory of the ball and the insert plate 12 is 30 degrees. The balls are subjected to 70 or more blows (firings) and are inspected at regular intervals for breakage (i.e., any signs of cover cracking or delamination). If a microcrack forms in a ball, its speed will change and the operator is alerted. The operator then visually inspects the ball. If the microcrack cannot yet be observed, the ball is returned to the test until a crack can be visually detected.

A ball is assigned a Durability Rating according to the following scale. A sample of twelve balls of the same type are obtained and are tested using the durability test apparatus described in the previous paragraph. If less than all of the balls in the sample survive 70 blows each without cracking, the ball is assigned a Durability Rating of 1. If all of the balls survive 70 blows and one or two of the twelve balls crack before 100 blows, the ball is assigned a Durability Rating of 2. If all twelve balls in the sample survive 100 blows each, but seven or more balls crack at less than 200 blows each, the ball is assigned a Durability Rating of 3. If all twelve balls in the sample survive 100 blows and at least six out of the twelve balls in the sample also survive 200 blows, the ball is assigned a Durability Rating of 4.

The spin rate of the golf ball is measured by striking the ball with a 9-iron wherein the club-head speed is about 105 feet per second and the ball is launched at an angle of 26 to 34 degrees with an initial velocity of about 110-115 feet per second. The spin is measured by observing the rotation of the ball in flight using stop action strobe photography.

"Shore D hardness" of a cover is measured generally in accordance with ASTM D-2240, except the measurements are made on the curved surface of a molded cover, rather than on a plaque. Furthermore, the Shore D hardness of the cover is measured while the cover remains over

the core. When a hardness measurement is made on a dimpled cover, Shore D hardness is measured at a land area of the dimpled cover.

EXAMPLES 1-28: Use of Nylon-Containing Ionomers in Golf Ball Covers

By blending the ingredients set forth in the following Tables, cover compositions were produced and injection molded around a core to yield a two piece ball as described above. The balls were then evaluated. The results are shown below:

Examples 1-3:

Examples 1-3 in Table 12 illustrate golf balls formed from compositions which include RP (Capron® 8351) with ethylene/methyl acrylate/acrylic acid terpolymers (Escor® ATX 325), and compositions formed from RP (Capron® 8351) with zinc neutralized ethylene/methyl acrylate/acrylic acid terpolymer ionomers (Iotek® 7520, and Iotek® 7510). The cover material was blended in a single screw extruder. Cold cracking of Examples 1 and 2 may have been a result of molding problems.

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Table 12

Example/component (grams)	1	2	3
Iotek® 7520	--	1500	--
Iotek® 7510	--	--	1500
Capron® 8351	1500	1500	1500
Escor® ATX 325	1500	--	--
Cold Crack Resistance	2 cracks at 2 blows 4 cracks at 3 blows	2 cracks at 3 blows 3 cracks at 5 blows	--
Durability - 300 hits	No Failures	No Failures	

Examples 4-9:

Examples 4-9 in Table 13 show compositions of nylon homopolymers (Capron® 8202) with ethylene/acrylic acid copolymer ionomers (Iotek® 7010 and Iotek® 8000), blends of ethylene/acrylic acid ionomers (Iotek® 7010 and Iotek® 8000), compositions of nylon homopolymers (Capron® 8202) with terpolymers (Escor® ATX 320) and terpolymer ionomers such as (Escor® ATX-320-Li-80), and of nylon homopolymers (Capron® 8202) and terpolymers (Escor® ATX 320) are shown. Blends A, B, C and D were each pre-extruded in a single screw extruder and were molded over cores having the same formulation, a Riehle compression in the range of 61 - 69 and a C.O.R. in the range of 0.766 - 0.778. Example 5 was a control in which no nylon was used. Examples 4 and 6 - 9 show that Nylon 6 can be blended with ionomeric copolymers to make a durable golf ball if sufficient mixing occurs. It was surprising that the inclusion of 10% nylon (Example 4) produced a cover that had nearly the same durability as Control Example 5. In Example 6, a preextrusion of zinc ionomer (Iotek® 7010) with nylon, followed by dry blending with sodium ionomer unexpectedly resulted in better durability than the balls of Example 4 although the covers of Examples 4 and 6 had the same overall composition. While the covers of Examples 7 and 8 were expected to break as a result of incompatibility, it was instead found that terpolymer and terpolymer ionomer were compatible with nylon, and no cracking occurred in the 300-blow durability test.

Table 13

Example/Component (grams)	4	5 (control)	6	7	8	9
Blend A[1]	2000	---	---	---	---	---
Blend B[2]	---	---	---	---	2000	---
Blend C[3]	---	---	---	2000	---	---
Blend D[4]	---	---	650	---	---	1000
Iotek® 8000	---	1500	1350	---	---	---
Iotek® 7010	---	500	---	---	---	---
Compression (Riehle)	59	60	59	74	75	60
Coefficient of Restitution	0.804	0.805	0.806	0.783	0.767	0.798
Durability[5]						
100 blows	12	12	12	12	12	12
200 blows	12	12	12	12	12	12
300 blows	7	8	9	12	12	5

[1] Sample taken from mixture of 2025g Iotek® 8000, 675g Iotek® 7010, and 300g Capron® 8202.

[2] Sample taken from mixture of 2700g Escor® ATX 320 and 300g Capron® 8202.

[3] Sample taken from mixture of 1350g Escor® ATX 320, 1350g Escor® ATX 320-Li-80, and 300g Capron® 8202.

[4] Sample taken from mixture of 1350g Iotek® 7010 and 600g Capron® 8202.

[5] Number of balls out of 12 which survived 100 blows, 200 blows and 300 blows

Examples 10-14:

Examples 10-14 in Table 14 illustrate compositions which employ one or more copolymer ionomers (Iotek®, Surlyn®) with Zytel®. These compositions were prepared and molded into golf balls according to the procedures above. The materials were blended using a single screw extruder. Example 11 produced the "best" ball of this set of Examples due to its high C.O.R.

Table 14

Example/ Component	10	11	12	13	14
Iotek® 4000	35 wt. %	42.5 wt. %	--	--	--
Iotek® 8000	35 wt. %	42.5 wt. %	--	--	--
Surlyn® 9910	--	--	85 wt. %	--	--
Surlyn® 9320	--	--	--	75 wt. %	50 wt. %
Zytel® 408	30 wt. %	15 wt. %	15 wt. %	25 wt. %	50 wt. %
C.O.R.	0.784	0.812	0.803	0.784	0.782
Compression (Riehle)	53	54	56	65	61
Hardness Shore D	70	70	67	50	62

Example 15:

Example 15 illustrates use of RP in the form of Capron® 8351 as the cover of a golf ball. The core had a Riehle compression in the range of 85 - 95 and a C.O.R. in the range of 0.772 - 0.789 and was the same type of core as was used in Examples 16 - 44. The performance of this ball is shown in Table 17. The resulting ball had low spin and high hardness, which would make it useful for a high handicap player.

Examples 16-20:

RP (Capron® 8351) was admixed with blend BX1 that included a sodium neutralized ethylene/acrylic acid copolymer ionomer, a first zinc neutralized ethylene/acrylic acid copolymer ionomer, and a component

mixture (masterbatch). The component mixture included a second zinc neutralized ethylene/acrylic acid copolymer ionomer. The second zinc neutralized ethylene/acrylic acid ionomer was different from the first zinc neutralized ethylene/acrylic acid copolymer ionomer.

More specifically, in Examples 16 - 20, Capron® 8351 was blended with blend BX1. In blend BX1, the first sodium neutralized ethylene/acrylic acid copolymer ionomer was Iotek® 8000 in an amount of 70 wt. % of blend BX1. The first zinc neutralized ethylene/acrylic acid copolymer ionomer was Iotek® 7010 in an amount of 20 wt. % of blend BX1. The component mixture formed 10 wt. % of blend BX1. The component mixture contained Iotek® 7030 as the second zinc neutralized ethylene/acrylic acid copolymer ionomer in an amount of 75 wt. % of the component mixture. The component mixture also included 24 wt. % of UV stabilizer, 0.26 wt. % brightener, 0.46 wt. % dye and 0.04 wt. % antioxidant. Blend BX1 was produced by dry blending the sodium and zinc copolymer ionomers with the component mixture. The component mixture employed in the blend BX1 was produced by melt extruding the ingredients of the component mixture at a temperature of about 380°F. Mixing of RP and blend BX1 took place using a twin screw extruder designed for intensive mixing. The RP was melt mixed with blend BX1 at a temperature of about 450°F. The resulting compositions then were molded into covers and balls as described above. The performance of balls according to Examples 16 - 20 is shown in Table 17.

Stated more generally, when Capron® 8351 and blend BX1 are used to form a golf ball cover, Capron® 8351 is about 1 to 99 wt. %, preferably about 20 wt. % to about 80 wt. %, more preferably about 20 wt. % of the composition, and blend BX1 is about 1 to 99 wt. %, preferably about 20 to about 80 wt. % of the composition, more preferably about 80 wt. % of the composition. In blend BX1, the first zinc neutralized ethylene/acrylic acid copolymer ionomer is about 1 to about 90 wt. %, preferably about 20 wt. % of blend BX1, the sodium neutralized ethylene/acrylic acid copolymer

ionomer is about 1 to about 90 wt. %, preferably about 70 wt. % of blend BX1, and the component mixture is about 1 to about 30 wt. %, preferably about 10 wt. % of blend BX1. Preferably, the second zinc neutralized ethylene/acrylic acid copolymer ionomer in the component mixture is about 75 wt. % of the component mixture, with the remainder being additives such as stabilizers for oxidative degradation, stabilizers for thermal degradation, stabilizers for ultraviolet light degradation, inhibitors for oxidative degradation, inhibitors for thermal degradation, inhibitors for ultraviolet light degradation, lubricants, plasticizers, dyes, pigments, fibrous fillers, particulate fillers, and reinforcement nucleating agents. In this embodiment, a wide variety of sodium ionomers including but not limited to those listed herein, preferably lotek® 8000 may be employed. The first zinc copolymer ionomer may be, for example, any of those listed herein, preferably lotek® 7010. The second zinc copolymer ionomer may be, for example, any of those listed herein, preferably lotek® 7030. The aforesaid component mixture preferably includes about 75 wt. % lotek® 7030, remainder additives.

As shown by the results in Table 17, the addition of nylon increased the hardness and C.O.R. of the balls, increased distance slightly, and reduced spin. It is important to note that the mixture of Capron® 8351 with ionomer resulted in a highly durable product except in Example 17, in which the balls broke early. The poor results of Example 17 may have been caused by inadequate molding.

Examples 21-24:

RP (Capron® 8351) and blend BX2 that includes a sodium neutralized ethylene/acrylic acid copolymer ionomer, a zinc neutralized ethylene/acrylic acid copolymer ionomer, and the above described component mixture were employed in a golf ball as a golf ball cover. Mixing of RP and blend BX2 took place using a twin screw extruder designed for intensive mixing.

In Examples 21-24, the first zinc neutralized ethylene/acrylic acid

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copolymer ionomer was EX1003 in an amount of 45% of blend BX2, the sodium neutralized ethylene/acrylic acid copolymer ionomer was EX1002 in an amount of 45 wt. % of blend BX2, and the component mixture was 10 wt. % of blend BX2. The second zinc neutralized ethylene/acrylic acid copolymer ionomer in the component mixture was Iotek® 7030 in an amount of 75 wt. % of the component mixture. The component mixture also included 24 wt. % UV stabilizer, 0.26 wt. % brightener, 0.46 wt. % dye and 0.04 wt. % antioxidant. The performance of balls with these covers is shown in Examples 21-24 of Table 17.

Stated more generally, in this embodiment, Capron® 8351 is about 1 to about 99 wt. %, preferably about 20 - 80 wt. %, more preferably about 20 wt. % of the composition, and blend BX2 is about 1 to about 99 wt. %, preferably about 20 - 80 wt. %, more preferably about 80 wt. % of the composition. In blend BX2, the sodium neutralized ethylene/acrylic acid copolymer ionomer is about 1 to about 90 wt. %, preferably about 45 wt. % of blend BX2, the zinc neutralized ethylene/acrylic acid copolymer ionomer is about 1 to about 90 wt. %, preferably about 45 wt. % of blend BX2, and the component mixture is about 1 to 30 wt. %, preferably about 10 wt. % of blend BX2. In this embodiment, the preferred sodium neutralized ionomer is EX1002 and the preferred zinc ionomer is EX1003. EX1002 and EX1003 are provided by Exxon Chemical Co. and the properties of EX1002 and EX1003 are shown in Table 15 below.

Table 15

Resin/Property	ASTM Method	EX 1002	EX 1003
Cation		Na	Zn
Melt Index (g/10 min)	D-1235	1.6	1.1
Melting Point (C)	D-3417	83.7	82
Crystallization Point (C)	D-3417	43.2	51.5
Plaque Properties (2mm thick compression molding)			
Tensile Strength at Break MPa	D-638	31.7	24.8
Yield Point MPa	D-638	22.5	14.9
Elongation at Break %	D-638	348	387
1% Secant Modulus MPa	D-638	418	145
1% Flexural Modulus MPa	D-790	380	147
Shore D Hardness	D-2240	62	54
Vicat Softening Point	D-1525	51.5	56

EX1002 is made by neutralizing an ethylene/acrylic acid copolymer having about 18 wt. % acrylic acid and a melt index of about 28 with sodium to achieve a sodium neutralized ethylene/acrylic acid copolymer ionomer that has a melt index of about 1. EX1003 is made by neutralizing an ethylene/acrylic acid copolymer having about 18 wt. % acrylic acid having a melt index of about 28 with zinc to yield a zinc neutralized ethylene/acrylic acid ionomer having a melt index of about 1. Blend BX2 is made in the manner employed to make blend BX1. Capron® 8351 and blend BX2 then are blended together. The resultant compositions then are formed into golf ball covers and golf balls as described above.

As was the case in Examples 16 - 20, Examples 21 - 24 also show that the addition of nylon increases the hardness and C.O.R. of the golf balls, and increases distance slightly while reducing spin.

Examples 25-28:

RP (Capron® 8351) with blend BX3 that included a sodium neutralized ethylene/acrylic acid copolymer ionomer, a zinc neutralized ethylene/acrylic acid copolymer ionomer, and the above described component mixture were employed in a golf ball as a golf ball cover. Mixing

of RP with blend BX3 was conducted using a twin screw extruder designed for intensive mixing. In Examples 25 - 28, the first neutralized ethylene/acrylic acid copolymer ionomer was EX 990 in an amount of 45 wt. % of blend BX3, the sodium neutralized ethylene/acrylic acid copolymer ionomer was EX 989 in an amount of 45 wt. % of blend BX3, and the component mixture was 10 wt. % of blend BX3. The second zinc neutralized ethylene/acrylic acid copolymer ionomer in the component mixture was Iotek® 7030 in an amount of 75 wt. % of the component mixture. The component mixture also included 24 wt. % UV stabilizer, 0.26 wt. % brightener, 0.46 wt. % dye and 0.04 wt. % antioxidant. The properties of EX 989 and EX 990, as provided by Exxon, are shown in Table 16. The performance of balls with covers of these compositions is shown in Examples 25-28 of Table 17.

Stated more generally, in this embodiment, Capron® 8351 is about 1 to about 99 wt. %, preferably about 20 - 80 wt. %, more preferably about 20 wt. % of the composition, and blend BX3 is about 1 to about 99 wt. %, preferably about 20 - 80 wt. %, more preferably about 80 wt. % of the composition. In blend BX3, the sodium neutralized ethylene/acrylic acid copolymer ionomer is about 1 to about 90 wt. %, preferably about 45 wt. % of blend BX3, the first Zn neutralized ethylene/acrylic acid copolymer ionomer is about 1 to 90 wt. %, preferably about 45 wt. % of blend BX3, and the component mixture is about 1 to 30 wt. %, preferably about 10 wt. % of blend BX3. In this embodiment, the preferred sodium ionomer is EX 989. The preferred zinc copolymer ionomer is EX 990. EX 989 is made by neutralizing an ethylene/acrylic acid copolymer that has about 18 wt. % acrylic acid and a melt index of about 100 with sodium. EX 990 is made by neutralizing an ethylene/acrylic acid copolymer that has about 18 wt. % acrylic acid and a melt index of about 100 with zinc. EX 989 and EX 990 are available from Exxon Chemical Co.

As indicated by the results on Table 17, Capron® 8351 produces a golf ball with excellent durability, as well as a very high coefficient of restitution and good distance, when used in combination with BX3.

Examples 20, 21 and 25 were controls. In each set of Examples 16 - 20, 21 - 24 and 25 - 28, intermolecular interactions are believed to have caused, or at least contributed to, the reduction in melt index for the blends as compared to the pure materials. Durability of the covers containing 20 wt. % Capron® 8351 is better than durability of covers containing 40 wt. % Capron® 8351. However, the 40 wt. % Capron ®8351 covers met the durability standard for commercial golf balls and resulted in a harder cover.

Table 16

Resin/Property	EX 989	EX 990
Melt Index (g/10 min)	1.3	1.24
Cation type	Na	Zn
Density (kg/m^3)	959	977
Vicat Softening Temp. (C)	52/5	55.0
Crystallization Temp. (C)	40.1	54.4
Melting Point (C)	92.6	81.0
Tensile at Yield (MPa)	23.8	16.5
Tensile at Break (MPa)	32.3	23.8
Elongation at Break (%)	389	357
1% Secant Modulus (MPa)	389	205
Flexural Modulus (MPa)	340	183
Hardness (Shore D)	62	56
Zwick Rebound (%)	61	48

Table 17

EX	% BX3	% BX2	% BX1	% C8351	MOLD TEMP[1]	MI[2]	SIZE[3]	Wt.[4]	COMP[5]	COR[6]	HARD[7]	SPIN[8]	DIST	DUR[9]	100[10] blows	200[11] blows	300[12] blows
15			0	100	465	5.51	1.679	45.92	56	808	77	5514	251.3**	258	12	10	9
16			20	80	465	3.13	1.677	45.57	60	801	75	5984	248.1**	155	9	2	0
17			40	60	460	0.43	1.68	45.52	65	B[13]	73	6891	235.0**	---[13]	---	---	---
18			60	40	450	0.9	1.68	45.41	71	803	72	---	248.8**	197	12	6	0
19			80	20	430	3.23	1.68	45.27	73	806	69	7777	249.6**	278	12	12	4
20			100	0	430	9.49	1.68	45.13	75	807	67	8375	248.1**	335	12	12	8
21		100		0	430	17.5	1.679	45.22	68	821	72	7028	264.7*	171	12	0	0
22		80		20	430	7.5	1.68	45.3	66	818	73	6988	263.8*	239	12	5	5
23		60		40	450	1.45	1.681	45.6	65	815	74	6434	262.8*	139	9	1	0
24		40		60	465	0.62	1.678	45.56	67	781	75	6300	264.2*	---[13]	---	---	---
25	100			0	430	15.8	1.68	45.26	68	819	72	6707	266.0*	157	12	1	0
26	80			20	430	8.08	1.68	45.32	67	819	73	6842	265.0*	253	12	7	4
27	60			40	430	2.8	1.679	45.38	56	816	75	6257	266.1*	172	11	2	0
28	40			60	465	1.39	1.681	45.73	62	813	77	6013	261.7*	55	1	0	0

[1] Degrees F [2] Melt Index--g/10min [3] Diameter in inches [4] Weight in grams
[5] Riehle Compression [6] Coefficient of Restitution [7] Hardness--Shore D [8] revs. per min.
[9] Durability--Average No. of hits to failure [10] Number of balls out of 12 which survived 100 blows
[11] Number of balls out of 12 which survived 200 blows [12] Number of balls out of 12 which survived 300 blows [13] Broke
* Yards total distance after impact with Top Flite® Tour metal wood having 10.5 Deg. loft at 157.96 ft/sec onto firm turf
** Yards total distance after impact with Top Flite® Tour metal wood having 12 Deg. loft at 163.3 ft/sec onto soft turf

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EXAMPLES 29-44: Use of Blends of Copolymer Ionomer and Nylon in Golf Ball Covers

Examples 29-34:

Capron® 8202 with the aforementioned blend BX1 was employed as a cover in a golf ball. The Capron® 8202 and blend BX1 were mixed using a twin screw extruder designed for intensive mixing.

In Examples 29 - 34, the sodium neutralized ethylene/acrylic acid copolymer ionomer was Iotek® 8000 in an amount of 70 wt. % of blend BX1, the first zinc neutralized ethylene/acrylic acid copolymer ionomer was Iotek® 7010 in an amount of 20 wt. % of blend BX1, and the component mixture is 10 wt. % of blend BX1. The second zinc neutralized ethylene/acrylic acid copolymer ionomer in the component mixture was Iotek® 7030 in an amount of 75 wt. % of the component mixture. The component mixture also included 24 wt. % of UV stabilizer, 0.26 wt. % brightener, 0.46 wt. % dye and 0.04 wt. % antioxidant. The performance of balls which employ those covers is shown as Examples 29 - 34 in Table 18 below.

Stated more generally, in this embodiment, Capron® 8202 is about 1 to about 50 wt. %, preferably about 20 - 50 wt. %, more preferably about 20 wt. % of the composition, and blend BX1 is about 50 to 99 wt. %, preferably about 50 - 80 wt. %, more preferably about 80 wt. % of the composition as long as a Durability Rating of at least 2 is obtained. The compositions are formed into golf ball covers and golf balls as described above.

Table 18

EX	% BX3	% BX2	% BX1	% C8202	MOLD TEMP[1]	MI[2]	SIZE[3]	Wt.[4]	COMP[5]	COR[6]	HARD[7]	SPIN[8]	DIST	DUR[9]	100[10] blows	200[11] blows	300[12] blows
29			0	100	465	14.38	1.68	46.3	43	B[13]	80	7412	---	---[13]	---	---	---
30			20	80	465	15.9	1.68	46.02	50	B[13]	78	--	---	---[13]	---	---	---
31			40	60	460	5.32	1.68	45.76	57	B[13]	75	--	---	---[13]	---	---	---
32			60	40	450	1.73	1.68	45.54	67	808	72	7056	251.6**	69	1	0	0
33			80	20	430	5.68	1.68	45.4	71	809	80	7845	250.9**	178	12	2	0
34			100	0	430	9.49	1.68	45.13	75	807	67	8375	248.1**	335	12	12	8
35		100		0	430	17.5	1.68	45.22	68	821	72	7028	264.7*	171	12	0	0
36		80		20	430	6.23	1.68	45.44	66	821	73	6375	265.5*	103	11	0	0
37		60		40	450	2.21	1.68	45.33	63	821	75	5826	265.8*	93	9	0	0
38		40		60	460	7.49	1.68	45.96	54	B[13]	80	4708	---	---[13]	---	---	---
39		0		100	465	14.38	1.68	46.3	43	B[13]	80	7412	---	---[13]	---	---	---
40	100			0	430	15.8	1.68	45.26	68	819	72	6707	266*	157	12	1	0
41	80			20	430	6.88	1.79	45.39	66	821	74	6607	266.5*	186	12	3	1
42	60			40	450	3.86	1.68	45.67	67	824	77	5656	267.1**	150	12	1	0
43	40			60	460	7.49	1.683	45.92	53	B[13]	80	B[13]	---	---[13]	---	---	---
44	0			100	465	14.38	1.68	46.3	73	B[13]	80	7412		---[13]	---	---	---

[1] Degrees F [2] Melt Index--g/10min [3] Diameter in inches [4] Weight in grams
[5] Riehle Compression [6] Coefficient of Restitution [7] Hardness--Shore D [8] RPM
[9] Durability--Average No. of hits to failure [10] Number of balls out of 12 which survived 100 blows
[11] Number of balls out of 12 which survived 200 blows [12] Number of balls out of 12 which survived 300 blows [13] Broke
* Yards total distance after impact with Top Flite® Tour metal wood having 10.5 Deg. loft at 157.96 ft/sec onto firm turf
** Yards total distance after impact with Top Flite® Tour metal wood having 12 Deg. loft at 163.3 ft/sec onto soft turf

Examples 35-39:

Capron® 8202 with the aforementioned blend BX2 was employed as a cover in a golf ball. The Capron® 8202 and blend BX2 were mixed using a twin screw extruder designed for intensive mixing.

In Examples 35-39, the sodium neutralized ethylene/acrylic acid copolymer ionomer was EX 1002 in an amount of 45 wt. % of blend BX2, the first zinc neutralized ethylene/acrylic acid copolymer ionomer was EX 1003 in an amount of 45 wt. % of blend BX2, and the component mixture was 10 wt. % of blend BX2. The second zinc neutralized ethylene/acrylic acid copolymer ionomer in the component mixture was Iotek® 7030 in an amount of 75 wt. % of the component mixture. The component mixture also included 24 wt. % UV stabilizer, 0.26 wt. % brightener, 0.46 wt. % dye and 0.04 wt. % antioxidant. The performance of balls with those covers is shown in Examples 35-39 of Table 18 above.

Stated more generally, in this embodiment, Capron® 8202 is about 1 to about 50 wt. %, preferably about 20 - 50 wt. %, more preferably about 20 wt. % of the composition, and blend BX2 is about 50 to about 99 wt. %, preferably about 50 - 80 wt. %, more preferably about 80 wt. % of the composition as long as a minimal Durability Rating of 2 is obtained. The compositions are formed into golf ball covers and golf balls as described above.

Examples 40-44:

Capron® 8202 with blend BX3 was employed as a golf ball cover of a golf ball. The Capron® 8202 and blend BX3 were mixed using a twin screw extruder designed for intensive mixing. In Examples 40 - 44, the first zinc neutralized ethylene/acrylic acid copolymer ionomer was EX 990 in an amount of 45 wt. % of blend BX3, the Na neutralized ethylene/acrylic acid copolymer ionomer was EX 989 in an amount of 45 wt. % of blend BX3, and the component mixture was 10 wt. % of blend BX3. The second zinc neutralized ethylene/acrylic acid copolymer ionomer in the component

mixture was Iotek® 7030 in an amount of 75 wt. % of the component mixture. The component mixture also included 24 wt. % UV stabilizer, 0.26 wt. % brightener, 0.46 wt. % dye and 0.04 wt. % antioxidant. The performance of balls with those covers is shown in Examples 40 - 44 of Table 18 above.

Stated more generally, in this embodiment, Capron® 8202 is about 1 to about 50 wt. %, preferably about 20 - 50 wt. %, more preferably about 20 wt. % of the composition, and blend BX3 is about 50 to about 99 wt. %, preferably about 50 - 80 wt. %, more preferably 80 wt. % of the composition as long as a minimal Durability Rating of 2 is obtained. The compositions are formed into golf ball covers and golf balls as described above.

EXAMPLES 45 - 59: Use of Blends of Terpolymer Ionomer and Nylon in Golf Ball Covers

Capron® 8351 was blended in different amounts with four different ionomeric or non-ionomeric terpolymers, namely Surlyn® 9320, Iotek® 7520, ATX 320-Li-40 and DS3076 (Chevron Chemical Co.). DS3076 is an extrusion grade sodium ionomer resin with a melt index of 0.5 g/10 min (ASTM D-1238) and a flexural modulus of 34,400 psi (ASTM D-790-66). Blending took place in a twin screw extruder designed for intensive mixing. The weight percentages of Capron® 8351 and the terpolymer materials are shown on Table 19 below. The blend was employed as a cover of a golf ball. The covers were placed over cores having the same formulation, Riehle compression in the range of 82 - 92, and C.O.R. in the range of 0.785 - 0.805. The physical properties and performance of the resulting balls is shown on Table 19. The inclusion of nylon increased cover hardness and reduced ball spin.

On Table 19, scuff resistance measurements were determined as follows:

A Top-Flite® tour pitching wedge (1994) with box grooves was obtained and was mounted in a Miyamae™ driving machine. The club face was oriented for a square hit. The forward/backward tee position was

adjusted so that the tee was four inches behind the point in the downswing where the club was vertical. The height of the tee and the toe-heel position of the club relative to the tee were adjusted in order that the center of the impact mark was about 3/4 of an inch above the sole and was centered toe to heel across the face. The machine was operated at a club head speed of 125 feet per second. A minimum of three samples of each ball were tested. Each ball was hit three times. After testing, the balls were rated according to the following table:

Rating	Type of Damage
Little or no damage (groove markings or dents)	1
Small cuts and/or ripples in cover	2
Moderate amount of material lifted from ball surface but still attached to ball	3
Material removed or barely attached	4

The balls that were tested were primed and top coated.

The addition of nylon caused a slight reduction in scuff resistance in Examples 45 - 48 and 49 - 52. However, Examples 45 and 49 - 51 were found to have a scuff resistance that was better than a number of commercially available "soft" golf balls, which typically have a scuff resistance of about 1.0. The "best balls" in this set of Examples were those of Examples 50 - 51 because they had a soft feel (i.e. low Shore D and relatively high spin) in conjunction with good scuff resistance.

Table 16

EX	% 9320	% 7520	% ATX	% DS3076	% C8351	MOLD TEMP	MI	SIZE	Wt.	COMP	C.O.R.	HARD[1]	SPIN	DIST D[2]	DIST I[3]	CC[4]	SCUFF[5]	DUR[6]
45	100				0		3.7	1.6790	45.35	80	781	71	10550	248	173	NF	0.5	NF
46	90				10		2.3	1.6790	45.55	81	781	74	10299	247	175	NF	1.5	NF
47	80				20		1.4	1.680	45.58	79	782	75	10086	248	175	NF	3.0	NF
48	70				30		0.6	1.6790	45.68	78	782	80	9549	248	177	NF	2.0	NF
49		100			0		6.7	1.680	45.52	80	781	69	10622	242	172	NF	0.5	NF
50		90			10		5.1	1.681	45.63	80	781	70	10578	247	173	NF	1.0	NF
51		80			20		3.6	1.681	45.67	80	779	74	10468	248	174	NF	1.0	NF
52		70			30		2.6	1.681	45.77	78	780	80	10245	248	175	1e3[7]	1.5	NF
53			100		0		3.1	1.679	45.37	80	782	74	10405	245	176	1e3[7]	1.5	NF
54			90		10		1.5	1.679	45.44	79	783	76	10318	247	177	NF	3.0	NF
55			80		20		1.2	1.680	45.60	79	783	80	10147	250	176	NF	4.0	NF
56			70		30		0.8	1.680	45.65	78	783	84	9559	249	178	NF	4.5	NF
57				100	0													
58				90	10													
59				80	20													

[1] Shore C hardness
[2] yards, with driver
[3] yards, with 9-iron
[4] cold crack
[5] scuff resistance
[6] NF= 12/12 balls survived 20 blows in C.O.R. machine at 150 - 160 ft/sec.
[7] one break at third blow (most possibly due to molding)

Examples 45, 49, 53 and 57 were controls. As indicated by the results on Table 19, the golf balls of Examples 46 - 48, 50 - 51 and 54 - 56 possessed good cold crack resistance. Example 52 was believed to fail because of poor/inadequate molding. The formations of Examples 57 - 59 could not be molded due to difficulties during the extrusion process.

EXAMPLES 60 - 68: Use of Blends of Lithium Ionomer and Nylon in Golf Ball Covers

Capron® 8202 and Capron® 8351 were blended with various ionomers. In some of the Examples, all of the Capron® and ionomers were pre-dried and co-extruded. In other Examples, the Capron® was predried and preextruded with one ionomer and subsequently dry blended with another ionomer. A single screw extruder was used. The results are shown on Table 20.

As indicated by the results on Table 20, blends of nylon with lithium ionomers resulted in good durability. Example 63 shows a golf ball with particularly high durability. Core type A had a Riehle compression in the range of 68 - 76 and a C.O.R. in the range of 0.795 - 0.805. Core type B had a Riehle compression in the range of 54 - 62 and a C.O.R. in the range of 0.789 - 0.797.

Table 20

	Pre-dried and Co-extruded						Dry Blended								
EX	% 996 LI	% 996 Na	% 7010	% BX1	% 8351	% 8202	% 7010	% 996 LI	COMP	C.O.R.	CORE TYPE	100[1] blows	200[2] blows	300[3] blows	DUR[4]
60	50		33.3			16.7			59	826	A	12	7	3	257
61	50					16.7	33.3		58	826	A	12	10	3	273
62			33.3			16.7		50	59	826	A	12	11	5	261
63	50		33.3		16.7				59	824	A	12	12	8	>300
64				100					60	822	A	12	12	11	>300
65	50		33.3		16.7				49	810	B	12	12	10	>300
66				100					50	806	B	12	12	11	>300
67		50				16.7	33.3		57	825	A	12	8	6	258
68		50	33.3			16.7			59	824	A	12	11	3	245

[1] Number of balls out of 12 which survived 100 blows
[2] Number of balls out of 12 which survived 200 blows
[3] Number of balls out of 12 which survived 300 blows
[4] Durability - average number of hits to failure

EXAMPLES 69 - 96: Use of Small Quantities of Nylon in Ionomeric Golf Ball Covers

A number of blends were made using up to 30 wt. % Capron® 8351 or 10 wt. % Capron® 8202. The cores were of the same formulation as those of Examples 15 - 28. A twin screw extruder was used for blending. The results are shown on Table 21.

As shown on Table 21, all of the samples exhibited good durability and had good C.O.R.

Table 21

Ex. #	% Ionomer	% 8351	% 8202	COMP	C.O.R.	Shore D	Cold Crack	100[1] blows	200[2] blows	300[3] blows	MI
Ionomer Resin is a dryblend of 8000/7010 75/25											
69	100	0		68	800	70	nb	12	12	7	5.3
70	90	10		66	801	71	nb	12	12	4	3.1
71	80	20		66	801	72	nb	12	12	1	2.4
72	70	30		65	800	72	nb	12	8	0	1.5
73	90		10	65	802	73	nb	12	12	2	3.1
Ionomer resin is a dryblend of 8000/7010 50/50											
Ex. #	% Ionomer	% 8351	% 8202	COMP	C.O.R.	Shore D	Cold Crack	100[1] blows	200[2] blows	300[3] blows	MI
74	100	0		66	803	71	nb	12	12	4	6.2
75	90	10		65	803	72	nb	12	12	11	5
76	80	20		64	803	74	nb	12	12	2	3.9
77	70	30		65	801	74	nb	12	12	1	2.1
78	90		10	66	803	73	nb	12	11	4	5.1
Ionomer resin is a dryblend of 1006/1007 50/50											
Ex. #	% Ionomer	% 8351	% 8202	COMP	C.O.R.	Shore D	Cold Crack	100[1] blows	200[2] blows	300[3] blows	MI
79	100	0		68	802	71	nb	12	12	4	6.7
80	90	10		67	800	71	nb	12	12	3	5.2
81	80	20		66	801	73	nb	12	12	4	3.5
82	70	30		65	798	74	nb	12	11	1	2
83	90		10	67	802	75	nb	12	12	7	5.2

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Ex. #	% Ionomer	% 8351	% 8202	Riehle	C.O.R.	Shore D	Cold Crack	100[1] blows	200[2] blows	300[3] blows	MI
Ionomer Resin is a dryblend of 1002/1003 50/50											
84	100	0		65	805	71	nb	12	12	2	11.2
85	90	10		65	805	72	nb	12	11	3	7.4
86	80	20		64	804	73	nb	12	10	0	4.6
87	70	30		67	810	75	1@5th blow	12	4	0	2.8
88	90		10	66	818	75	nb	12	12	0	5
Ionomer resin is a dryblend of AD8195/AD8444 50/50											
Ex. #	**% Ionomer**	**% 8351**		**Riehle**	**C.O.R.**	**Shore D**	**Cold Crack**	**100[1] blows**	**200[2] blows**	**300[3] blows**	**MI**
89	100	0		66	818	72	nb	12	12	0	13.8
90	90	10		65	816	73	nb	12	12	1	10
91	80	20		65	815	74	nb	12	9	1	7.2
92	70	30		64	813	75	nb	12	11	0	8.1
Ionomer resin is a dry blend of AD8195/AD8181 50/50											
Ex. #	**% Ionomer**	**% 8351**		**Riehle**	**C.O.R.**	**Shore D**	**Cold Crack**	**100[1] blows**	**200[2] blows**	**300[3] blows**	**MI**
93	100	0		66	815	73	nb	12	12	0	6.3
94	490	10		67	817	74	nb	12	9	0	4.3
95	80	20		66	814	74	nb	12	7	0	4.3
96	70	30		64	812	75	nb	12	4	0	2.3

Iotek® 8000 15%AA Na Precursor 37MI
Iotek® 7010 15%AA Zn Precursor 37MI
Iotek® 1006 15%AA Na Precursor 20MI
Iotek® 1007 15%AA Zn Precursor 20MI

Iotek® 1002 18%AA Na Precursor 28MI
Iotek® 1003 18%AA Zn Precursor 28MI
AD 8195 Zn
AD 8444 Na
AD 8181 Li

[1] Number of balls out of 12 which survived 100 blows
[2] Number of balls out of 12 which survived 200 blows
[3] Number of balls out of 12 which survived 300 blows

EXAMPLES 97 - 143: Tensile Data for Ionomers and Nylon-Ionomer Blends

Tensile data was collected for a number of blends of ionomer and nylon. The results are shown on Table 22. The addition of nylon generally increased tensile modulus and energy to break.

Table 22

Ex.	Ionomer	Nylon Type	% Nylon	Break Stress PSI	% Strain @ Break	Energy to Break In-Lb	Yield Stress PSI	% Strain @ Yield	Modulus[1] PSI
97	8000/7010 (75/25)	---	0	3666	211.3	58.8	3203	20.7	26825
98		8351	10	3834	224.3	65.9	3314	21.4	27723
99		8351	20	3985	217.8	67	3483	22.1	28777
100	"	8351	30	4158	220	70.8	3659	24.9	30363
101	"	8202	10	3751	211.8	62	3412	21.6	27254
102	8000/7010 (50/50)	---	0	3496	232.5	62	3151	20.1	25930
103	"	8351	10	3635	241.6	67.3	3196	20.1	26196
104	"	8351	20	3869	265.1	76	3193	20.2	26920
105	"	8351	30	4075	257.5	77.8	3355	21.8	26928
106	"	8202	10	3684	248.2	69.1	3179	20.9	25584
107	1006/1007 (50/50)	---	0	3551	239.6	66.1	3162	19.9	26335
108	"	8351	10	3677	252.8	71.4	3125	20.4	26070
109	"	8351	20	3995	254.5	76.2	3320	20.7	27938
110	"	8351	30	4056	246.1	75.7	3389	22	29071
111	"	8202	10	3556	234.8	65.7	3207	19.8	27561
112	1002/1003 (50/50)	---	0	3759	251.8	72.5	3586	18.1	30593
113	"	8351	10	4007	276.4	81.5	3530	18.4	30491
114	"	8351	20	4107	277.4	84	3551	18.8	30589
115	"	8351	30	4305	277.3	87.7	3683	18.1	30671

1 tensile modulus

Table 22

Ex. #	Ionomer	Nylon	% Nylon	Break Stress PSI	% Strain @ Break	Energy to Break In-Lb	Yield Stress PSI	% Strain @ Yield	Modulus[1] PSI
116	1002/1003 (50/50)	8202	10	4481	317.2	99.8	3675	17.8	32585
117	---	8351	100	8927	478.8	255.1	5085	25.8	56870
118		8351	100	8312	500.4	247.2	4785	27.5	42281
119	BX1	8351	40	5323	293	106.2	3606	20.6	30198
120	BX1	8351	20	4584	265	81.8	3293	19.5	28032
121	BX1		0	3907	216.9	62.8	3305	21.6	26094
122		8202	100	8434	422.4	248	7064	19.8	63744
123	BX1	8202	80	9223	518.9	288.8	5973	17.8	58195
124	BX1	8202	60	7920	484	238.3	5510	18.9	58424
125	BX1	8202	40	6072	397.6	158.5	4771	18.1	45577
126	BX1	8202	20	4538	281.4	96.4	4090	20.7	35404
127	BX1		0	3907	216.9	62.8	3305	21.6	26094
128	BX2		0	3489	217.2	61.8	3603	19.2	29755
129	BX2	8351	20	3732	245.8	71.3	3540	19.5	29814
130	BX2	8351	40	5465	352.6	125.2	3834	20.7	32862
131	BX2	8351	60	7449	459.7	212	4408	34.4	37181
132	BX2		0	3489	217.2	61.8	3603	19.2	29755
133	BX2	8202	20	4760	314.6	111.7	4462	18.3	37510
134	BX2	8202	40	6484	422.4	174.4	4971	18.4	44209

Ex. #	Ionomer	Nylon Type	% Nylon	Break Stress PSI	% Strain @ Break	Energy to Break In-Lb	Yield Stress PSI	% Strain at Yield	Modulus[1] PSI
135	BX2	8202	60	7202	456.6	214.4	5288	21.3	49705
136	BX3		0	3647	184.2	55.3	3866	19.5	31580
137	BX3	8351	20	4010	231.7	72.2	3884	19.6	32011
138	BX3	8351	40	5342	327.2	118.2	4058	22.5	32499
139	BX3	8351	60	7266	454.5	211.2	4695	27.8	43427
140	BX3		0	3647	184.2	55.3	3866	19.5	31580
141	BX3	8202	20	4820	323.8	105.5	3768	18.2	32422
142	BX3	8202	40	6341	448.2	177.2	4236	17.4	40094
143	BX3	8202	60	7910	486.9	232.7	5154	20.1	50535

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Examples 144 - 150:

Various coverstock blends were formed using a blend of Amodel® ET-1001 or Amodel® AT-1001 polyphthalamide with ionomer resin such as Surlyn® 8140 and Surlyn® 6120.

As shown by the results on Table 23, blends of polyphthalamide with ionomers showed good durability. Particularly, Examples 144 and 148 show golf ball compositions with a high durability. Also, Examples 144-150 exhibited high C.O.R. values.

Table 23

Example	144	145	146	147	148	149	150
Amodel® ET-1001 (grams)	600	900	1200				
Amodel® AT-1001 (grams)				600	900	1200	
Surlyn® 8140 (grams)	1050	900	750	1050	900	750	1350
Surlyn® 6120 (grams)	1050	900	750	1050	900	750	1350
TGMB 2832 (grams)	300	300	300	300	300	300	300
AS MOLDED							
Size (inches)	1.679	1.68	1.68	1.68	1.68	1.681	1.681
Weight (grams)	45.5	45.64	45.91	45.45	45.58	45.77	45.23
Riehle Compression	67	65	63	67	66	64	70.5
C.O.R.	0.815	0.8138	0.8123	0.8162	0.8147	0.8118	0.8152
SD Coefficient	0.0008	0.0012	0.0022	0.0013	0.0009	0.0012	0.0009
Barrel to Destruction *(average number of hits to failure)*	873.67	369.8	148.25	552.92	320.5	496.67	328.08
FINISHED							
Size (inches)	1.681	1.681	1.681	1.68	1.681	1.682	1.681
Weight (grams)	45.62	45.76	46.04	45.5	45.72	45.89	45.32
Riehle Compression	63	61	59	64	63	62	66
C.O.R.	0.8186	0.817	0.816	0.819	0.8184	0.8147	0.8203
SD Coefficient	0.0005	0.0015	0.0013	0.001	0.0009	0.0016	0.0008
Shore D	74	76	78	74	75	74	72
Cold Crack	1 @ 5	No Failures	10 @ 2	No Failures	No Failures	3 @ 2	No Failures
			2 @ 5			3 @ 3	
						2 @ 5	

Examples 151-174:

A variety of cover blends were formed using Amodel® AT-1001 and/or Amodel® ET-1001 polyphthalamide with ionomer resin such as EX1002, EX1003, EX5091, and EX5092. The particular blend amounts of each material is shown in Table 24.

Table 24

Example	151	152	153	154	155	156	157	158	159	160	161	162
Amodel® AT 1001	800 g	1200 g	1600 g				800 g	1200 g	1600 g			
Amodel® ET 1001				800 g	1200 g	1600 g				800 g	1200 g	1600 g
EX 1002	994 g	854 g	714 g	994 g	854 g	714 g	1420 g	1220 g	1020 g	1420 g	1220 g	1020 g
EX 1003	1846 g	1586 g	1326 g	1846 g	1586 g	1326 g	1420 g	1220 g	1020 g	1420 g	1220 g	1020 g
TGMB	360 g	360 g	360 g	360 g	360 g	360 g	360 g	360 g	360 g	360 g	360 g	360 g
Amodel® Ionomer	20/(35/65)	30/(35/65)	40/(35/65)	20/(35/65)	30/(35/65)	40/(35/65)	20/(50/50)	30/(50/50)	40/(50/50)	20/(50/50)	30/(50/50)	40/(50/50)
Example	163	164	165	166	167	168	169	170	171	172	173	174
Amodel® AT 1001	800 g	1200 g	1600 g				800 g	1200 g	1600 g			
Amodel® ET 1001				800 g	1200 g	1600 g				800 g	1200 g	1600 g
EX 5091	994 g	854 g	714 g	994 g	854 g	714 g	1420 g	1220 g	1020 g	1420 g	1220 g	1020 g
EX 5092	1846 g	1586 g	1326 g	1846 g	1586 g	1326 g	1420 g	1220 g	1020 g	1420 g	1220 g	1020 g
TGMB	360 g	360 g	360 g	360 g	360 g	360 g	360 g	360 g	360 g	360 g	360 g	360 g
Amodel® Ionomer	20/(35/65)	30/(35/65)	40/(35/65)	20/(35/65)	30/(35/65)	40/(35/65)	20/(50/50)	30/(50/50)	40/(50/50)	20/(50/50)	30/(50/50)	40/(50/50)

Example 175:

A golf ball having the same coverstock blend as the ball found in Example 153 was placed through a series of tests to determine coefficient of restitution, cold crack resistance, Barrel durability, S_D coefficient, and Riehle compression. The results of the golf ball tests are shown on Table 25 and are compared to the results found in the commercially available Strata® golf ball from Spalding Sports Worldwide, Inc., which serves here as the control.

Table 25

	STRATA® CONTROL	EXAMPLE 175
Finished		
Size	1.681"	1.679"
Weight	45.53 g	45.53 g
Riehle	81	81
COR	.7839	.7855
S_DCOR	.0016	.0023
Cold Crack	1 @ 2 1 @ 3 1 @ 4	No failures
As Molded		
Size	1.680"	1.679"
Weight	45.42 g	45.44 g
Riehle	85	84
COR	.7842	.7857
S_DCOR	.0024	.0023
Barrel:	No failures	No failures

In any of the compositions employed in the invention, additional materials may be added to these compositions employed to provide desired properties. These materials include, for example, dyes such as Ultramarine™ sold by Witaker, Clark and Daniels of South Plainfield, NJ,

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titanium dioxide, UV absorbers and stabilizers. The compositions also may include softening agents such as plasticizers and reinforcing materials such as glass fibers and inorganic fillers. Antioxidants also may be included in the compositions of the invention, conventionally in amounts of about 1% by weight. Useful antioxidants include 4,4'-di (1,1,3,3-tetramethylbutyl) diphenylamine sold under the trade designation Octamine Antioxidant™ by Naugatuck Division of US Rubber. Also useful is the hydroperoxide decomposer antidegradant tetrakis (2,4-ditertbutylphenyl)-4,4'-biphenylenediphosphonite sold under the trade designation Sandostab™ P-EPQ by Sandoz Colors & Chemicals Co.

The compositions employed in the invention may be prepared by any conventional procedure that provides a substantially uniform admixture of the components. Preferably drying and melt blending procedures and equipment are used. For example, in preparation of compositions which employ nylon materials such as RP with one or more terpolymers and/or terpolymer ionomers, the terpolymer and/or terpolymer ionomer can be dry mixed with RP, typically at room temperature, and the resulting mixture melt blended in any conventional type blending equipment heated to about 200-250°C. The nylon material and the copolymer, terpolymer, terpolymer ionomer, and/or copolymer ionomer preferably are dried (either individually or together) before melt blending. Drying is done in desiccated air at a temperature and for a time suitable to reduce the moisture content to a point which it will not have any adverse effect on the subsequent use of the compositions or the properties of the resulting product. If additives such as those identified above have not previously been added to either the nylon material, the copolymer or copolymer ionomer during processing of those individual components, i.e., before they are admixed with each other, the additives may be added during melt blending of those components. The uniform admixture resulting from the melt blending procedure then may be commuted by chopping, pelletizing or grinding into granules, pellets, chips, flakes or powders suitable for subsequent use, e.g. injection molding to provide a golf ball.

The invention has been described with reference to the preferred embodiments. Modification and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such alterations and modifications insofar as they come within the scope of the claims and the equivalents thereof.